DETAILED TECHNICAL SPECIFICATIONS OF EQUIPMENTS/MATERIAL/WORKS FOR CONSTRUCTION OF 2X132 KV BAYS AT 220 KV MATHURAPUR GSS OF BSEB AND 132 KV DOUBLE CIRCUIT TRANSMISSION LINE FROM MATHURAPUR GSS TO NEW KARWANDIYA TSS

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1. SURGE ARRESTER

1. General

The surge arresters shall conform in general to IEC-60099-1 or IEC-60099-4 except to the extent explicitly modified in the specification.

1.1 The bidder shall offer surge arresters of gapless type without any series or shunt gap.

1.2 Arresters shall be hermetically sealed units, of self supporting construction, suitable for mounting on structures.

2. Duty Requirements

2.1 The surge arresters shall be of heavy duty station class type.

2.2 The surge arresters shall be capable of discharging over voltage occurring during switching of unloaded transformers and reactors.

2.3 Surge arresters shall be capable of spark over on severe switching surges and multiple strokes.

2.4 The surge arresters shall be able to withstand wind load calculated at 195 kg/sq.m.

2.5 The gapless arrester, if provided, shall meet following additional requirements.

2.5.1 It shall be fully stabilized thermally to give a life expectancy of 100 years under site conditions and shall take care of the effect of direct solar radiation.

2.5.2 The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

3. Constructional Features

The features and constructional details of surge arresters shall be in accordance with requirement stipulated hereunder:

3.1 Gapless Type Surge Arrester

3.1.1 The non linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent electrical and mechanical properties even after repeated operations.

3.1.2 The surge arresters shall be fitted with pressure relief devices and arc diverting parts suitable for preventing shattering of porcelain housing and providing path for flow of rated fault currents in the event of arrester failure.

3.1.3 The arresters shall incorporate anti-contamination feature to prevent arrester failure consequent to uneven voltage gradient across the stack in the event of contamination of the arrester porcelain.

3.1.4 Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

3.1.5 Outer insulator shall be porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfection that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Glazing of porcelain shall be of uniform brown colour, free from blisters, burrs and other similar defects. Porcelain housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrester.

3.1.6 The end fittings shall be made of non-magnetic and corrosion proof material.

3.1.7 The name plate shall conform to the requirement of IEC incorporating the year of manufacture.

3.1.8 The arrester shall be supplied with suitable support structure either of tubular GI pipe or lattice steel galvanized.

3.1.9 The heat treatment cycle details along with necessary quality checks used for individual blocks along with insulation layer formed across each block to be furnished. Metalised coating thickness for reduced resistance between adjacent discs to be furnished along with procedure for checking the same. Details of thermal stability test for uniform current distribution of current on individual disc to be furnished.

3.2 Fittings and Accessories

3.2.1 Each arrester shall be complete with insulating base, support structure and terminal connector. The height of the support structure shall not be less than 2500 mm. The structure would be made of galvanized steel generally conforming to IS:802. The surge arrester can also be mounted on the neutral grounding reactor in lieu of separate support structure.

3.2.2 Self contained discharge counter, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation, shall be provided for each unit. The counter shall be visible through an inspection window from ground level. The counter terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends.

3.2.3 Suitable milliammeter on each arrester with appropriate connections shall be supplied to measure the resistor grading leakage current. The push buttons shall be mounted such that

it can be operated from ground level.

3.2.4 Discharge counter and milliammeter shall be suitable for mounting on support structure of the arrester.

3.2.5 Grading/Corona rings shall be provided on each complete arrester unit as required for proper stress distribution.

4 Tests

4.1 The surge arresters shall conform to type tests and shall be subjected to routine tests as per IEC-60099.1/IEC-60099.4.

4.2 **Surge arrester shall be subjected to additional acceptance tess.**

(i) Construction check (visual check)

(ii) Measurement of insulation resistance by 1kV megger.

5 Gapless Surge Arresters shall fulfil the following technical requirements

5.1	Rated arrester voltage	120 kV
5. 2	Rated system voltage	145 kV
5. 3	Rated system frequency	50Hz
5. 4	System neutral earthing	Effectively earthed
5. 5	Installation	Outdoor
5. 6	Nominal discharge current	10kA of 8/20 micro sec wave.
5. 7	Class of arrester	10kA heavy duty type
5. 8	Minimum discharge capacity	3.5 kJ/kV (referred to rated voltage)
5. 9	Continuous operating voltage at 50Ø C	102kV
5. 10	Maximum switching surge residual voltage (1kA)	280kVp
5. 11	Maximum residual voltage at	
	(i) 5kA	320kVp
	(ii) 10kA nominal discharge current	340kVp

5. 12	Long duration discharge class	2
5. 13	High current short duration test value (4/10microsec. wave)	100kAp
5. 14	Current for pressure relief test	40kArms
5. 15	Low current long duration test value (2000microsec.)	1000Apeak
5. 16	Min. total creepage distance.	3625 mm.
5. 17	One minute dry power frequency withstand voltage of arrester housing.	275kVrms
5. 18	Impulse withstand voltage of arrester housing with 1.2/50 microsec. Wave	+650KVp
5. 19	Pressure relief class	A
5. 20	RIV at 92 kVrms.	Less than 500microvolts
5. 21	Partial discharge at 1.05 continuous over voltage	Not more than 50pC
5. 22	Seismic acceleration	0.3 g horizontal.
5. 23	Reference ambient temperature	50 deg C

2. POWER & CONTROL CABLES

1. POWER & CONTROL CABLES[FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V]

1.1 CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

1.1.1. Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose from LT Aux. Transformers to control room, between distribution boards and for supply for switchyard lighting from control room.

1.1.2 Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switchyard area/control room except for control/protection purposes.

1.1.3 For all control/protection/instrumentation purposes PVC insulated armoured control cables of minimum 2.5 sq. mm. size with stranded Copper conductors shall be used.

1.1.4 BSEB has standardised the sizes of power cables for various feeders. Bidders are to estimate the quantity of cables and quote accordingly. The sizes of power cables to be used per feeder in different application shall be as follows

S.No.	From	To	Cable size	Cable type
1.	Main Switch Board	LT Transformer	2-1C X 630 mm^2 per phase 1-1C X 630 mm^2 for neutral	XLPE
2.	Main Switch Board	AC Distribution Board	2-3½C X 300 mm^2	XLPE
3.	Main Switch Board	Oil Filtration Unit	1-3½C X 300 mm^2	XLPE
4.	Main Switch Board	Colony Lighting	1-3½C X 300 mm^2	XLPE
5.	Main Switch Board	HVW pump LCP(Not applicable for this project)	1-3½C X 300 mm^2	XLPE
6.	Main Switch Board	***Main*** Lighting ***distribution board***	1-3½C X 300 mm^2	XLPE

1.1.5 Bidder may offer sizes other than the sizes specified in clause 1.1.4. In such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for purchaser's approval.

1.1.6 Cables shall be laid conforming to IS : 1255.

1.1.7 While preparing cable schedules for control/protection purpose following shall be ensured:

1.1.7.1 Separate cables shall be used for AC & DC.

1.1.7.2 Separate cables shall be used for DC1 & DC2.

1.1.8 For different cores of CT & CVT separate cable shall be used

1.1.9 Atleast one (1) cores shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.

1.1.10 For control cabling, including CT/VT circuits, 2.5 sq.mm. size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration additional cores shall be used. Further for potential circuits of energy meters separate connections by 2 cores of 2.5 sq.mm. size shall be provided.

1.1.11 Standard technical data sheets for cable sizes up to and including 1100V are enclosed at Annexure. Cable sizes shall be offered/manufactured in accordance with parameters specified in standard technical data sheets. Technical data sheet for any other cores/sizes required during detailed engineering shall be separately offered for owner's approval by the contractor/supplier.

1.2. TECHNICAL REQUIREMENTS

1.2.1. General

1.2.1.1. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

1.2.1.2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE/PVC insulated L.T. power cables of sizes 240 sq. mm. and above shall withstand without damage a 3 phase fault current of at least 45 kA for at least 0.12 second, with an initial peak of 105 kA in one of the phases at rated conductor temperature (70 degC for PVC insulated cables and 90 degC for XLPE insulated cables).The armour for these power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.

1.2.1.3. The XLPE insulated cables shall be capable of withstanding a conductor temperature

of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

1.2.1.4. The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All **A**luminium used in the cables for conductors shall be of H2 grade. In case of single core cables armours shall be of H4 grade Aluminium.

1.2.1.5. The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

1.2.1.6. Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

1.2.1.7. Strip wire armouring method (a) mentioned in Table 5, Page-6 of IS : 1554 (Part 1) – 1988 shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.

1.2.1.8. The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

1.2.1.9. All the cables shall pass fire resistance test as per IS:1554 (Part-I)

1.2.1.10. The normal current rating of all PVC insulated cables shall be as per IS:3961.

1.2.1.11. Repaired cables shall not be accepted.

1.2.1.12. Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

1.2.2. **XLPE Power Cables**

1.2.2.1. The XLPE **(90°C**) insulated cables shall be of FR type, C1 category conforming to IS:7098 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded alluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS:5831 for all XLPE cables.

1.2.3. **PVC Power Cables**

1.2.3.1. The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IS: 1554 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to

Type ST-1 of IS: 5831 for all cables.

1.2.4. **PVC Control Cables**

1.2.4.1. The PVC ***(70°C) insulated*** control cables shall be of FR t ype C1 category conforming to IS: 1554 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour .

1.2.4.2. Cores shall be identified as per IS: 1554 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per Clause 10.3 of IS: 1554 (Part-1).

2. CABLE DRUMS

2.1 Cables shall be supplied in returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

2.2 Standard lengths for each size of power and control cables shall be 500/ 1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The owner shall have the option of rejecting cable drums with shorter lengths. Maximum, One (1) number non standard length of cable size(s) may be supplied in drums for completion of project.

2.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

2.4 A clear space of at least 40 mm shall be left between the cables and the lagging.

2.5 Each drums shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

2.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

3. TYPE TESTS

3.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

3.2 XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V):-

3.2.1 Following type tests (on one size in a contract) as per IS: 7098 (Part 1) – 1988 including its amendments shall be carried out as a part of acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V:

a) Physical tests for insulation
   i) Hot set test
   ii) Shrinkage test
b) Physical tests for outer sheath i) Shrinkage test
   ii) Hot deformation iii) Heat shock test iv) Thermal stability

3.2.2 ***Contractor shall submit type test reports as per technical Specification, Section: GTR for the following tests-***

a) Water absorption (gravimetric) test.
b) Ageing in air oven
c) Loss of mass in air oven
d) Short time current test on power cables of sizes 240 sqmm and above on i) Conductors. ii) Armours.
e) Test for armouring wires/strips.
f) Oxygen and Temperature Index test. g) Flammability test.

3.3 ***PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)-***

3.3.1 Following type tests ***(on one size in a contract)*** as per IS: 1554 (Part 1) - 1988 including its amendments shall be carried out ***as a part of acceptance tests*** on PVC insulated ***power & control*** cables ***for working voltages up to and including 1100 V:***

a) Physical tests for insulation and outer sheath i) Shrinkage test
   ii) Hot deformation iii) Heat shock test iv) Thermal stability
b) High voltage test (water immersion test only a.c. test as per clause no. 16.3.1).

3.3.2 ***Contractor shall submit type test reports as per Technical Specification, Section: GTR for the following-***

a) High voltage test (water immersion d.c. test as per clause no. 16.3.2 of IS: 1554 (Part 1) - 1988).
b) Ageing in air oven.
c) Loss of mass in air oven.

d) Short time current test on power cables of sizes 240 sqmm and above on

i) Conductors. ii) Armours.

e) Test for armouring wires/strips.

f) Oxygen and Temperature Index test. g) Flammability test.

STANDARD TECHNICAL DATA SHEET (1.1 kV GRADE XLPE POWER CABLES)

SN				
	CUSTOMER :	DFCCIL		
	Name of manufacturer :	**As per approved list**		
	Cable Sizes	**1 C x 630**		**3½ C x 300**
1	**Manufacturer's type designation**	: **A2XWaY**		**A2XWY**
2	**Applicable standard**	: **----------IS: 7098/PT-I/1988 & its referred specifications----------**		
3	**Rated Voltage(volts)**	: **----------1100 V grade----------**		
4	**Type & Category**	: **FR & C1**		**FR & C1**
5	**Suitable for earthed or unearthed system**	: **----------for both----------**		
6	**Continuous current rating when laid in air in a ambient temp. of 50 ^{o}C and for maximum conductor temp. of 70 ^{o}C of PVC Cables[For information only]**	: **732**		**410**
7	**Rating factors applicable to the current ratings for various conditions of installation:**	: **----------As per IS-3961-Pt-II-67----------**		
8	**Short circuit Capacity**			
	a) Guranteed Short Circuit Amp. (rms)KA for 0.12 sec duration at rated conductor temperature of 90 degree C, with an initial peak of 105 KA.	: **45 KA**		**45 KA**
	b) Maximum Conductor temp. allowed for the short circuit duty (deg C.) as stated above.	: **----------250 ^{o}C----------**		
9	**Conductor**			
	a) Material	**Stranded Aluminium as per Class 2 of IS : 8130**		
	b) Grade	: **---------- H 2 (Electrolytic grade) ----------**		
	c) Cross Section area (Sq.mm.)	: **630**		**300/150**
	d) Number of wires(No.)minimum	: **53**		**30/15**
	e) Form of Conductor	**Stranded and compacted circular**		**Stranded compacted circular/sector shaped**
	f) Direction of lay of stranded layers	: **-------- Outermost layer shall be R.H lay & opposite in successive layers --------**		
10	**Conductor resistance (DC) at 20 ^{o}C per km-maximum**	**0.0469**		**0.1 / 0.206**
11	**Insulation**			
	a) Composition of insulation	: **----------Extruded XLPE as per IS-7098 Part(1)----------**		
	b) Nominal thickness of insulation(mm)	: **2.8**		**1.8/1.4**
	c) Minimum thickness of insulation	: **2.42**		**1.52/1.16**
12	**Inner Sheath**			
	a) Material	: **----------Extruded PVC type ST-2 as per IS-5831-84----------**		
	b) Calculated diameter over the laid up cores,(mm)	: **NA**		**52**
	c) Thickness of Sheath (minimum)mm	: **N.A**		**0.6**
	d) Method of extrusion	**NA**		**Pressure/Vacuum extrusion**
13	**Armour**			
	a) Type and material of armour	: **Al. Wire[H4 grade]**		**Gal. Steel wire**
	b) Direction of armouring	: **----------left hand----------**		
	c) Calculated diameter of cable over inner sheath (under armour), mm	: **33.9**		**53.2**
	d)Nominal diameter of round armour wire (minimum)	: **2**		**2.5**
	e)Guranteed Short circuit capacity of the armour for 0.12 sec at room temperature.	**45 KA**		**45 KA**
	f) DC resistance at 20 ^{o}C (Ω/Km)	**$**		**0.577**
14	**Outer Sheath**			
	a) Material (PVC Type)	: **ST-2& FR**		**ST-2& FR**
	b) Calculated diameter under the sheath	: **38.3**		**59.50**
	c) Min.thickness of sheath(mm)	: **1.72**		**2.36**
	d) Guaranteed value of minimum oxygen index of outer sheath at 27 ^{o}C	**Min 29.0**		**Min 29.0**
	e) Guranteed value of minimum temperature index at 21 oxygen index	**Min 250**		**Min 250**
	f) colour of sheath	: **Black**		**Black**
15	**a) Nominal Overall diameter of cable**	**$**		**$**
	b) Tolerance on overall diameter (mm)	: **----------+2/-2 mm----------**		
16	**Cable Drums**	: **---------- shall conform to IS 10418 and technical specification**		
	a) Max./ Standard length per drum for each size of cable (single length) with ±5% Tolerance (mtrs)	**1000/500**		**1000/500**
	b) Non standard drum lengths	**: Maximum one(1) non standard lengths of each cable size may be supplied in drums only over & above the standard lengths as specified above.(if required for completion of project).**		
17	**Whether progressive sequential marking on outer sheath provided at 1 meter interval**	: **---------- YES ----------**		
18	**Identification of cores**			
	a) colour of cores	**As per IS 7098 Part(1)**		
	b) Numbering	: **---------- N.A ----------**		
19	**Whether Cables offered are ISI marked**	: **---------- YES ----------**		
20	**Whether Cables offered are suitable for laying as per IS 1255**	: **---------- YES ----------**		

$'- As per manufacturer design data

STANDARD TECHNICAL DATA SHEET
(1.1 kV GRADE PVC POWER CABLES)

SN							
	CUSTOMER :	DFCCIL					
	Name of manufacturer :	As per approved list					
	Cable Sizes	1 c x 150	3.5 cx 70	3.5 cx 35	4 c x 16	4c x 6	2 c x 6
1	Manufacturer's type designation	: AYWaY	AYFY	AYFY	AYFY	AYWY	AYWY
2	Applicable standard	: ---------- ----------IS: 1554/PT-I/1988 & its referred standards----------					
3	Rated Voltage(volts)	: ----------1100 V grade----------					
4	Type & Category	: FR & C1	FR & C1	FR & C1	FR & C1	FR & C1	FR & C1
5	Suitable for earthed or unearthed system	: ----------for both----------					
6	Continuous current rating when laid in air in a ambient temp. of 50^{o}C and for maximum conductor temp. of 70 ^{o}C of PVC Cables[For information only]	: 202	105	70	41	24	28
7	Rating factors applicable to the current ratings for various conditions of installation:	: x----------As per IS-3961-Pt-II-67----------					
8	Short circuit Capacity						
	a) Short Circuit Amp. (rms)KA for 1 sec duration	: 11.2	5.22	2.61	1.19	0.448	0.448
	b) Conductor temp. allowed for the short circuit duty (deg C.)	: ----------160 ^{o}C----------					
9	Conductor						
	a) Material	: ----------STRANDED ALUMINIUM ----------					
	b) Grade	: ---------- H 2 (Electrolytic grade) ----------					
	c) Cross Section area (Sq.mm.)	: 150	M-70 N-35	M-35 N-16	16	6	6
	d) Number of wires(No.)	: ---------- as per Table 2 of IS 8130 ----------					
	e) Form of Conductor	Non-compacted Standed circular	shaped conductor	shaped conductor	shaped conductor	Non-compacted Standed circular	Non-compacted Standed circular
	f) Direction of lay of stranded layers	: -------- Outermost layer shall be R.H lay & opposite in successive layers --------					
10	Conductor resistance (DC) at 20 ^{o}C per km-maximum	0.206	0.443/ 0.868	0.868/ 1.91	1.91	4.61	4.61
11	Insulation						
	a) Composition of insulation	: ----------Extruded PVC type A as per IS-5831-84----------					
	b) Nominal thickness of insulation(mm)	: 2.1	1.4/1.2	1.2/1.0	1.0	1.0	1.0
	c) Minimum thickness of insulation	: 1.79	1.16/0.98	0.98/0.8	0.8	0.8	0.8
12	Inner Sheath						
	a) Material	: ----------Extruded PVC type ST-I as per IS-5831-84----------					
	b) Calculated diameter over the laid up cores,(mm)	: N.A	27.6	20.4	15.7	11.6	9.6
	c) Thickness of Sheath (minimum)mm	: N.A	0.4	0.3	0.3	0.3	0.3
13	Armour	: ---------- as per IS 3975/88 ----------					
	a) Type and material of armour	: Al. Wire[H4 grade]	Gal.steel strip	Gal.steel strip	Gal.steel strip	Gal. Steel wire	Gal. Steel wire
	b) Direction of armouring	: ----------left hand----------					
	c) Calculated diameter of cable over inner sheath (under armour), mm	: 18	28.4	21	16.3	12.2	10.2
	d) Nominal diameter of round armour wire/strip	: 1.6	4 x 0.8	4 x 0.8	4 x 0.8	1.4	1.4
	e) Number of armour wires/strips	: ----------Armouring shall be as close as practicable----------					
	f) Short circuit capacity of the armour along for 1 sec-for info only	: --K x A$\sqrt{t}$ (K Amp)(where A = total area of armour in mm^{2}& t = time in seconds), K=0.091 for Al & 0.05 for steel					
	g) DC resistance at 20 ^{o}C (Ω/Km)	: 0.44	2.57	3.38	3.99	3.76	4.4
14	Outer Sheath						
	a) Material (PVC Type)	: ST-1& FR	ST-1& FR	ST-1& FR	ST-1& FR	ST-1& FR	ST-1& FR
	b) Calculated diameter under the sheath	: 21.2	30.1	22.6	17.9	15	13
	c) Min.thickness of sheath(mm)	: 1.4	1.56	1.4	1.4	1.4	1.24
	d) Guaranteed value of minimum oxygen index of outer sheath at 27^{o}C	Min 29.0	Min 29.0	Min 29.0	Min 29.0	Min 29.0	Min 29.0
	e) Guranteed value of minimum temperature index at 21 oxygen index	Min 250	Min 250	Min 250	Min 250	Min 250	Min 250
	f) colour of sheath	: Black	Black	Black	Black	Black	Black
15	a) Overall diameter of cable	;----------$----------					
	b) Tolerance on overall diameter (mm)	: ----------+2/-2 mm----------					
16	Cable Drums	: ---------- shall conform to IS 10418 and technical specification					
	a) Max./ Standard length per drum for each size of cable (single length) with ±5% Tolerance (mtrs)	1000/500	1000/500	1000/500	1000/500	1000/500	1000/500
	b) Non standard drum lengths	: Maximum one(1) non standard lengths of each cable size may be supplied in drums only over & above the standard lengths as specified above.(if required for completion of project).					
17	Whether progressive sequential marking on outer sheath provided	: ---------- YES ----------					
18	Identification of cores						
	a) colour of cores	Red	R,Y,Bl &Bk	R,Y,Bl &Bk	R,Y,Bl &Bk	R,Y,Bl &Bk	Red & Bk
	b) Numbering	: ---------- N.A ----------					
19	Whether Cables offered are ISI marked	: ---------- YES ----------					
20	Whether Cables offered are suitable for laying as per IS 1255	: ---------- YES ----------					

$'- As per manufacturer design data

STANDARD TECHNICAL DATA SHEET
(1.1 kV GRADE PVC CONTROL CABLES)

SN									
	CUSTOMER :	DFCCIL							
	Name of manufacturer :	As per approved list							
	Cable Sizes	2c x 2.5	3c x 2.5	5c x 2.5	7c x 2.5	10c x 2.5	14c x 2.5	19c x 2.5	27c x
1	Manufacturer's type designation	YWY	YWY	YWY	YWY	YWY	YWY	YWY	YWY
2	Applicable standard	IS: 1554/PT-I/1988 & its referred standards							
3	Rated Voltage(volts)	1100							
4	Type & Category	FR & C1							
5	Suitable for earthed or unearthed system	for both							
6	Continuous current rating when laid in air in a ambient temp. of 50°C and for maximum conductor temp. of 70°C of PVC Cables[For information only]	22	19	19	14	12	10.5	9.7	8
7	Rating factors applicable to the current ratings for various conditions of installation:	As per IS-3961-Pt-II-67							
8	Short circuit Capacity								
	a) Short Circuit Amp. (rms)KA for 1 sec-for information only	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.285
	b) Conductor temp. allowed for the short circuit duty (deg C.)	160 °C							
9	Conductor								
	a) Material	Plain annealed High Conductivity stranded Copper (as per IS 8130/84)							
	b) Grade	Electrolytic							
	c) Cross Section area (Sq.mm.)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	d) Number of wires(No.)	as per Table 2 of IS 8130							
	e) Form of Conductor	Non-Compacted stranded circular conductor							
	f) Direction of lay of stranded layers	Outermost layer shall be R.H lay							
10	Conductor resistance (DC) at 20 °C per km(maxm)	7.41	7.41	7.41	7.41	7.41	7.41	7.41	7.41
11	Insulation								
	a) Composition of insulation	Extruded PVC type A as per IS-5831-84							
	b) Nominal thickness of insulation(mm)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	c) Minimum thickness of insulation	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
12	Inner Sheath								
	a) Material	Extruded PVC type ST-I as per IS-5831-84							
	b) Calculated diameter over the laid up cores,(mm)	7.2	7.8	9.7	10.8	14.4	15.9	18	22.1
	c) Thickness of Sheath (minimum)mm	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
13	Armour	as per IS 3975/99							
	a) Type and material of armour	Gal. Steel wire	Gal. Steel wire	Gal. Steel wire	Gal. Steel wire	Gal. Steel wire	Gal. Steel wire	Gal. Steel wire	Gal. Steel wire
	b) Direction of armouring	left land							
	c) Calculated diameter of cable over inner sheath (under armour), mm	7.8	8.4	10.3	11.4	15	16.5	18.6	22.7
	d) Nominal diameter of round armour wire / dimensions of armour strip	1.4	1.4	1.4	1.4	1.6	1.6	1.6	1.6
	e) Number of armour wires	Armouring shall be as close as practicable							
	f) Short circuit capacity of the armour and duration-for info only	--0.05 x A·t (K Amp)(where A = total area of armour in mm² & t = time in seconds)							
	g) DC resistance at 20 °C (Ω/Km) & Resistivity of armour	As per IS 1554 Part(1), whereever applicable & IS 3975-1999							
14	Outer Sheath								
	a) Material (PVC Type)	ST-1& FR	ST-1& FR	ST-1& FR	ST-1& FR	ST-1& FR	ST-1& FR	ST-1& FR	ST-1&
	b) Calculated diameter under the sheath	10.6	11.2	13.1	14.2	18.2	19.7	21.8	25.9
	c) Min.thickness of sheath(mm)	1.24	1.24	1.24	1.24	1.4	1.4	1.4	1.56
	d) Guaranteed value of minimum oxygen index of outer sheath	Min 29.0	Min 29.0	Min 29.0	Min 29.0	Min 29.0	Min 29.0	Min 29.0	Min 29.0
	e) Guranteed value of minimum temperature index at 21 oxygen index	Min 250	Min 250	Min 250	Min 250	Min 250	Min 250	Min 250	Min 250
	f) colour of sheath	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey
15	a) Overall diameter of cable	$							
	b) Tolerance on overall diameter (mm)	+2/-2 mm							
16	Cable Drums	shall conform to IS 10418 and technical specification							
	a) Max./ Standard length per drum for each size of cable (single length) with ±5% Tolerance (mtrs)	1000/500	1000/500	1000/500	1000/500	1000/500	1000/500	1000/500	1000/500
	b) Non standard drum lengths	Maximum one(1) non standard lengths of each cable size may be supplied in drums only over & above the standard lengths as specified above.(if required for completion of project).							
17	Whether progressive sequential marking on outer sheath provided	YES							
18	Identification of cores								
	a) colour of cores	R & Bk	R,Y &BlR,Y,Bl,Bk&	Grey	Grey	Grey	Grey	Grey	
	b) Numbering	N.A.	N.A.	N.A.	Numeral Numerals s in black ink	Numeral s in black ink	Numeral s in black ink	Numeral s in black ink	in black ink
19	Whether Cables offered are ISI marked	YES							
20	Whether Cables offered are suitable for laying as per IS 1255	YES							

$'- As per manufacturer design data

3. Control & Relay Panel

1. TYPE OF PANELS

Simplex Panel

Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from rear for control panels & either front or rear for relay panels. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock.

Duplex Panel

Duplex panel shall be walk-in tunnel type comprising two vertical front and rear panel sections connected back-on-back by formed sheet steel roof tie members and a central corridor in between. The corridor shall facilitate access to internal wiring and external cable connections. In case of number of duplex panels located in a row side by side, the central corridor shall be aligned to form a continuous passage. Both ends of the corridor shall be provided with double leaf doors with lift off hinges. Doors shall have handles either with built-in locking facility or shall be provided with pad-locks. Separate cable entries shall be provided for the front and rear panels. However, inter-connections between front and back panels shall be by means of inter panel wiring at the top of the panel.

2. CONSTRUCTIONAL FEATURES

2.1 Control and Relay Board shall be of panels of simplex or duplex type design as indicated in bill of quantity. It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes be properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

2.2 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS: 2147.

2.3 Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base

frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

2.4 All doors, removable covers and panels shall be gasketed all around with synthetic rubber gaskets Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh

2.5 Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

2.6 Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials that shall be supplied by the contractor, shall be placed between panel & base frame.

2.7 Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.

2.8 Relay panels of modern modular construction would also be acceptable.

3. MOUNTING

3.1 All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush.

3.2 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

3.3 The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

3.4 The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel

3.5 The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

3.6 No equipment shall be mounted on the doors.

3.7 At existing station, panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement of equipment (centre lines of switches, push buttons and other equipment) on the front of the panel.

4. PANEL INTERNAL WIRING

4.1 Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal

blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally

4.2 All wiring shall be carried out with 650V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

- All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 1.5mm sq. per lead.
- All current transformer circuits one 2.5 sq.mm lead.
- Voltage transformer circuit (for energy meters): Two 2.5 mm sq.per lead.

4.3 All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

4.4 Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

4.5 Wire termination shall be made with solderless crimping type and tinned copper lugs , which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

4.6 Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.7 Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments

5. TERMINAL BLOCKS

5.1. All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 650 V grade and have 10 Amps. continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

5.2. Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

5.3. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

5.4. Unless otherwise specified, terminal blocks shall be suitable for connecting the

following conductors of external cable on each side

- All CT & PT circuits: minimum of two of 2.5mm Sq. copper.
- AC/DC Power Supply Circuits : One of 6mm Sq. Aluminium.
- All other circuits: minimum of one of 2.5mm Sq. Copper.

5.5. There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

5.6. Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the Owner's external cable connections. All adjacent terminal blocks shall also share this field wiring corridor.All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

5.7. The number and sizes of the Owner's multi core incoming external cables will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of supply.

6. PAINTING

6.1 All sheet steel work shall be phosphated in accordance with the IS:6005 "Code of practice for phosphating iron and steel".

6.2 Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

6.3 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with a slightly alkaline hot water and drying.

6.4 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

6.5 The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

6.6 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting.

6.7 A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

6.8 In case the bidder proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted for POWERGRID's review and approval.

7. MIMIC DIAGRAM

7.1. Coloured mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.

7.2 Mimic diagram shall be made preferably of anodised aluminium or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. Painted overlaid mimic is also acceptable. The mimic bus shall be 2mm thick. The width of the mimic bus shall be 10mm for bus bars and 7mm for other connections.

7.3 Mimic bus colour will be as per BSEB conventions.

7.4 When semaphore indicators are used for equipment position they shall be so mounted in the mimic that the equipment close position shall complete the continuity of mimic.

7.5 Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition

8. NAME PLATES AND MARKINGS

8.1 All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/feeder designation.

8.2 All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

8.3 Each instrument and meter shall be prominently marked with the quantity measured e.g. KV, A, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

8.4 Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Name plates shall be black with white engraving lettering.

8.5 Each switch shall bear clear inscription identifying its function e.g. 'BREAKER"52A', "SYNCHRONISING" etc. Similar inscription shall also be provided on each device whose function is not other-wise identified. If any switch device does not bear this inscription separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indication e.g. "Trip- Neutral-Close", "ON-OFF", "R-Y-B-OFF" etc

8.6 All the panels shall be provided with name plates mounted inside the panel bearing LOA No & Date , Name of the Substation & feeder andreference drawing number.

9. MISCELLANEOUS ACCESSORIES

9.1 **Plug Point** : 240V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

9.2 **Interior Lighting** : Each panel shall be provided with a fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

9.3 **Switches and Fuses**: Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various

control, signaling, lighting and space heater circuits. The incoming and sub- circuits shall be separately provided with **Fuses**. Selection of the main and sub- circuit **Fuses** rating shall be such as to ensure selective clearance of sub-circuit faults. Voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. **The short time fuse rating of Fuses shall be not less than 9 KA.** Fuse carrier base shall have imprints of the fuse
'rating' and 'voltage'.

9.4 **Space Heater** : Each panel shall be provided with a **thermostatically connected** space heater rated for 240V , single phase , 50 Hz Ac supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit

10. EARTHING

10.1 All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq.mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing.When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

10.2 Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.

10.3 All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm.The colour code of earthing wires shall be green.

10.4 Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be

provided.

10.5 VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

11. INDICATING INSTRUMENTS, RECORDERS & TRANSDUCERS

All instruments, meters, recorders and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All megawatt ,megavar, Bus voltage and frequency dicating instruments shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery. However no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronising equipment.

11.1 Indicating Instruments

11.1.1 Unless otherwise specified, all electrical indicating instruments shall be of digital type suitable for flush mounting.

11.1.2 Instruments shall have 4-digit display; display height being not less than 25 mm

11.1.3 Instrument shall confirm to relevant IS and shall have an accuracy class of 1.5 or better Watt and Var meters shall have an indication of (+) and (-) to indicate EXPORT and IMPORT respectively.

11.1.4 Digital voltage and frequency meters shall be of class: 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than25mm (height).

11.2 Bus Voltage & Frequency Recording Instruments

11.2.1 Recording instruments shall be square or rectangular in shape and shall be suitable for flush mounting on panels. They shall be of 'draw out' type and suitable for back connection.

11.2.2 Recorders shall be furnished in dust tight metal cases with gasketed doors and they shall be designed so as to require minimum maintenance.

11.2.3 The recorder shall

i). be single pen type employing potentionmeteric servo drive principle.

ii). be of continuous recording type with disposable fibre tip cartridge pens, employing ink on paper.

iii). have a Calibrated Chart width of at least 100 mm and a viewing area of 100x50mm, at least.

iv). have an accuracy of $\pm$ 1.0% span.

v). have full span response time of less than 2 seconds.

i) have maximum chart speed facility of 60mm per hour.

ii) be directly calibrated for CT and PT ratios in use.

vi). be provided with chart rolls of adequate length requiring replacement, not earlier than 27 days. The quantity of chart rolls and ink included with the offer shall be 1000 metre length of paper and five pens with each recorder.

vi). be suitable for operation with station DC source, in case of AC supply (230 volts, 1 phase, 50Hz) failure (inverter may be included ,if required) .

11.2.4 Alternatively, Static/Digital type frequency recorder and voltage recorder either as individual units or composite unit for total substation with time tagged information shall also be acceptable if it meets the accuracy of $\pm$ 1.0% span and full span response time of less than 2 seconds. The static/digital shall also meet the high voltage susceptibility test , impulse voltage with stand test , high frequency disturbance test –class III and fast transient disturbance test –

level III as per IEC 60255.

11.3 **Transducers**

11.3.1 Transducers (for use with Indicating Instruments and Telemetry/Data Communication application) shall in general conform to IEC:688-1

11.3.2 The transducers shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

11.3.3 The input to the transducers will be from sub-station current & potential transformers. The output shall be in milli ampere D.C. proportional to the input & it shall be possible to feed the output current directly to the telemetry terminal or indicating instruments.

11.3.4 The transducer characteristic shall be linear throughout the measuring range.

11.3.5 The transducer output shall be load independent.

11.3.6 The input & output of the transducer shall be galvanically isolated.

11.3.7 Each transducer shall be housed in a separate compact case and have suitable terminals for inputs & outputs.

11.3.8 The transducers shall be suitably protected against transient high peaks of voltage & current.

11.3.9 The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.

11.3.10 All the transducers shall have an output of 4-20 mA**.**

11.3.11 The response time of the transducers shall be less than 1 second.

11.3.12 The accuracy class of transducers shall be 1.0 or better for voltage/current transducer, 0.5 or better for watt/VAR transducer and 0.2 or better for frequency transducer.

11.3.13 The transducers shall have a low AC ripple on output less than 1%.

11.3.14. The transducers shall be suitable for load resistance of 1000-1500

11.3.15. The transducer shall have dual output.

12. ANNUNCIATION SYSTEM

12.1. Alarm annunciation system shall be provided in the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification.

12.2. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels.

12.3. The annunciator facia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.

12.4. Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high illumination intensity (350 Lux), from the location of the operator's desk.

12.5. All Trip facia shall have red colour and all Non-trip facia shall have white colour.

12.6. The audible alarm shall be provided by Buzzer/ Hooter /Bell having different sounds and shall be used as follows.

Hooter	Alarm Annunciation
Bell	Annunciation DC failure
Buzzer	AC supply failure

12.7. Sequence of operation of the annunciator shall be as follows :

SN	Alarm Condition	Fault Contract	Visual Annunciation	Audible Annunciation
1	Normal	Open	Off	Off
2	Abnormal	Close	Flashing	On
3	Accept Push Button	Close	Steady	Off
	Pressed	Open	On	Off
4	Reset Push Button Pressed	Close	Steady	Off
		Open	On	On
		Off	Off	Off
5	Lamp Test Push Button	Open	Steady	Off
	Pressed	On	Off	Off

12.8 Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 240 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds. (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the

supply to annunciation system is restored .

12.9 A separate voltage check relay shall be provided to monitor the failure of supply (240V AC) to the scheme mentioned in Clause above. If the failure of supply exists for more than 2 to 3 seconds. this relay shall initiate visual and audible annunciation. Visual and audible annunciation for the failure of AC supply to the annunciation system shall be provided and this annunciation shall operate on Annunciation DC and buzzer shall sound.

12.10 The annunciation system described above shall meet the following additional requirements :

a) The annunciation system shall be capable of catering to at least 20 simultaneous signals at a time.

b) One set of the following push buttons shall be provided on each control panel:

- Reset push button for annunciation system.
- Accept push button for annunciation system.
- Lamp test push button for testing the facia windows

c) One set of the following items shall be provided common for all the control panel (not applicable for extension of substation) :

- Flasher relay for annunciation system.
- Push button for Flasher test .
- Three Push buttons for test of all audible alarm systems

d) These testing circuits shall be so connected that while testing is being done it shall not prevent the registering of any new annunciation that may land during the test

e) The annunciation shall be repetitive type and shall be capable of registering the fleeting signal.Minimum duration of the fleeting signal registered by the system shall be 15 milli seconds.

f) In case of static annunciator scheme, special precaution shall be taken to ensure that spurious alarm condition does not appear due to influence of external electromagnetic/ electrostatic interference on the annunciator wiring and switching disturbances from the neighbouring circuits within the panels and the static annunciator shall meet the high voltage susceptibility test , impulse voltage with stand test , high frequency disturbance test– class III and fast transient disturbance test –level III as per IEC 60255.

12.11. The annunciation system to be supplied for existing sub-stations shall be engineered as an extension to the existing scheme.

13. SWITCHES

13.1 Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

13.2 The selection of operating handles for the different types of switches shall be as

follows :

Breaker, Isolator control switches	:	Pistol grip, black
Synchronising switches	:	Oval, Black, Keyed handle (one common removable handle for a group of switches or locking facility having common key)
synchronising Selector switches	:	Oval or knob, black Instrument
switches	:	Round, knurled, black Protection
Transfer switch	:	Pistol grip, lockable and black.

13.3 The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively.

13.4 Instrument selection switches shall be of maintained contact (stay put) type.Ammeter selection switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondary when changing the position of the switch. Voltmeter transfer switches for AC shall be suitable for reading all line- to-line and line-to-neutral voltages for non effectively earthed systems and for reading all line to line voltages for effectively earthed systems.

13.5 Synchronising switches shall be of maintained contact (stay put) type having a common removable handle for a group of switches. The handle shall be removable only in the OFF position and it shall be co-ordinated to fit in to all the synchronising switches. These switches shall be arranged to connect the synchronising equipment when turned to the 'ON' position. One contact of each switch shall be connected in the closing circuit of the respective breaker so that the breaker cannot be closed until the switch is turned to the 'ON' position.

13.6 Lockable type of switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

13.7 The contacts of all switches shall preferably open and close with snap action to minimise arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts

13.8 The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.

13.9 The contact rating of the switches shall be as follows :

Description	**Contact rating in Amps**		
	220VDC	**50V DC**	**240V AC**
Make and carry Continuously	10	10	
Make and carry for 0.5 sec.	30	30	30
Break for:			

Resistive load	20	7
Inductive load	-	-
with L/R = 40m sec.		

14. INDICATING LAMPS

14.1 Indicating lamps shall be of cluster LED type suitable for panel mounting with rear terminal connections. .Lamps shall be provided with series connected resistors preferably built in the lamp assembly. Lamps shall have translucent lamp covers to diffuse lights coloured red ,green, amber ,clear white or blue as specified .The lamp cover shall be preferably of screwed type ,unbreakable and moulded from heat resisting material.

14.2 The lamps shall be provided with suitable resistors .

14.3 Lamps and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools ,if required for replacing the bulbs and lenses shall also be included in the scope of the supply.

14.4 The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis.

15. POSITION INDICATORS

15.1 Position indicators of "SEMAPHORE" type shall be provided when specified as part of the mimic diagrams on panels for indicating the position of circuit breakers, isolating/earthing switches etc. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear. Their strips shall be of the same colour as the associated mimic.

15.2 Position indicator shall be suitable for DC Voltage as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic bus bars, and at right angles to them when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure.

15.3 The rating of the indicator shall not exceed 2.5 W.

15.4 The position indicators shall withstand 120% of rated voltage on a continuous basis.

16. RELAYS

16.1 All relays shall conform to the requirements of IS:3231/IEC-60255 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

16.2 All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.

16.3 All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

16.4 The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme, contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.

16.5 All protective relays, auxiliary relays and timers except the lock out relays and interlocking relays specified shall be provided with self-reset type contacts. All protective relays and timers shall be provided with externally hand reset positive action operation indicators with inscription. All protective relays which do not have built-in hand-reset operation indicators shall have additional auxiliary relays with operating indicators (Flag relays) for this purpose. Similarly, separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as Bucholtz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.

16.6 Timers shall be of the electromagnetic or solid state type. Pneumatic timers are not acceptable. Short time delays in terms of milliseconds may be obtained by using copper slugs on auxiliary relays. In such case it shall be ensured that the continuous rating of the relay is not affected. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided to the extent possible.

16.7 No control relay which shall trip the power circuit breaker when the relay is de-energised shall be employed in the circuits.

16.8 Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

16.9 Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:

(a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

(b) Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.

(c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.

16.10 All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.

16.11 The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

16.12 Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the B.S.E.B.

16.13 The bidder shall include in his bid a list of installations where the relays quoted have been in satisfactory operation.

16.14 All relays and their drawings shall have phase indications as R-Red, Y-yellow, B-blue

16.15 Wherever numerical relays are used, the scope shall include the following:

a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.

b) The relay shall have suitable communication facility for future connectivity to SCADA. The relay shall be capable of supporting IEC 870-5-103 protocol. Neither the interface hardware nor the software for connectivity to SCADA will form part of the scope of this specification.

c) In case of Numerical line protection and Numerical transformer/reactor differential protection, the features like disturbance recorder and event logging function as available in these relays shall be supplied and activated in addition to requirement specified for disturbance recorder and event logging elsewhere in the specification.

17. TRANSMISSION LINE PROTECTION

17.1 The line protection relays are required to protect the line and clear the faults on line within shortest possible time with reliability, selectivity and full sensitivity to all type of faults on lines. The general concept is to have two main protections having equal performance requirement specially in respect of time as called Main-I and Main-II for 132 KV lines. The general concept is to have Main and back up protection for 33 KV lines.

17.2 The Transmission system for which the line protection equipment are required is detailed in specification. The length of lines and the line parameters (Electrical Constants) are also indicated there.

17.3 The maximum fault current could be as high as 40 kA but the minimum fault current could be as low as 20% of rated current of CT secondary. The starting & measuring relays characteristics should be satisfactory under these extremely varying conditions.

17.4 The protective relays shall be suitable for use with capacitor voltage transformers as well as Potential Transformers/ Voltage Transformers having non-electronic damping and transient response as per IEC.

17.5 Disturbance Recorder, Distance to fault Locator and Over voltage relay (stage - 1) functions if offered as an integral part of line protection relay, shall be acceptable provided these meet the technical requirements as specified in the respective clauses.

17.6 Auto reclose relay function if offered as an integral part of line distance protection relay, shall be acceptable for 132 KV lines provided the auto reclose relay feature meets the technical requirements as specified in the respective clause.

17.7 The following protections shall be provided for each of the Transmission lines:

For 132KV

Main: Numerical distance protection scheme
Back up : Directional Over current and Earth fault Protection

17.8 However, Phase segregated phase/direction comparison protection, Protection based on directional wave detection principle, phase segregated line differential protection as Main 2 protection in place of Numerical distance protection scheme shall be provided if specified in the specification.

17.9 Further, if specified, back up Over current and Earth fault protection shall be provided instead of Main -II protection scheme for 220KV lines to match with requirements at the remote ends.

17.10 The detailed description of the above line protections is given here under.

17.10.1 **Main-I & Main-II Numerical Distance Protection scheme** :

(a) shall be numerical type and shall have continuous self monitoring and diagnostic feature.

(b) shall be non-switched type with separate measurements for all phase to phase and

phase to ground faults

(c) shall have stepped time-distance characteristics and three independent zones (zone 1, zone-2 and zone-3)

(d) shall have mho or quadrilateral or other suitably shaped characteristics for zone-1 , zone-2 and zone- 3.

(e) shall have following maximum operating time (including trip relay time , if any) under given set of conditions and with CVT being used on line (with all filters included) .

(i) for 132 KV lines :
A relaxation of 5 ms in above timings is allowed for 132 KV lines.

(f) The relay shall have an adjustable characteristics angle setting range of 30 - 75 degree or shall have independent resistance(R) and reactance (X) setting.

(g) shall have two independent continuously variable time setting range of 0-3 seconds for zone-2 and 0-5 seconds for zone-3.

(h) shall have resetting time of less than 55 milli-seconds (including the resetting time of trip relays)

(i) shall have facilities for offset features with adjustable 10-20% of Zone-3 setting.

(j) shall have variable residual compensation.

(k) shall have memory circuits with defined characteristics in all three phases to ensure correct operation during close-up 3 phase faults and other adverse conditions and shall operate instantaneously when circuit breaker is closed to zero-volt 3 phase fault

(l) shall have weak end in-feed feature

(m) shall be suitable for single & three phase tripping.

(n) shall have a continuous current rating of two times of rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall also be capable of carrying a high short time current of 70 times rated current without damage for a period of 1 sec.

(o) shall be provided with necessary self reset type trip duty contacts for completion of the scheme (Minimum number of these trip duty contacts shall be four per phase) either through built in or through separate high speed trip relays . Making capacity of these trip contacts shall be 30 amp for 0.2 seconds with an inductive load of L/R > 10 mill seconds . If separate high speed trip relays are used , the operating time of the same shall not be more than 10 milliseconds

(p) shall be suitable for use in permissive under reach / over reach /blocking communication mode .

(q) shall have suitable number of potential free contacts for Carrier aided

Tripping, Auto reclosing, Event Logger, Disturbance recorder & Data acquisi- tion system.

(r) include power swing blocking protection which shall

- have suitable setting range to encircle the distance protection described above.
- block tripping during power swing conditions.

(s) include fuse failure protection which shall

- monitor all the three fuses of C.V.T. and associated cable against open circuit.
- inhibit trip circuits on operation and initiate annunciation.
- have an operating time less than 7 milliseconds
- remain inoperative for system earth faults

(t) include a directional back up Inverse Definite Minimum Time (IDMT) earth fault relay with normal inverse characteristics as per IEC 60255-3 as a built in feature or as a separate unit for 400 KV and 220KV transmission lines

(u) In case the numerical distance relay is not having the built in feature as per above clause (t), the same can be supplied as an independent relay

17.10.2 **Back-up Directional Over Current and Earth fault protection scheme**

(a) shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s

(b) Numerical type

(c) The scheme shall include necessary VT fuse failure relays for alarm purposes .

(d) Directional over current relay shall

- have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
- have a variable setting range of 50-200% of rated current
- have a characteristic angle of 30/45 degree lead

- include hand reset flag indicators or LEDs.

(e) Directional earth fault relay shall

- have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
- have a variable setting range of 20-80% of rated current
- have a characteristic angle of 45/60 degree lag
- include hand reset flag indicators or LEDs
- include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay.

17.10.3 All trip relays used in transmission line protection scheme shall be of self/electrical reset type depending on application requirement.

18. **AUTO RECLOSING RELAY** shall

(a) have single phase and three phase reclosing facilities.

(b) have a continuously variable single phase dead time range of 0.1-2 seconds.

(c) have a continuously variable three phase dead time range of 0.1-2 seconds.

(d) have a continuously variable reclaim time range of 5-25 seconds.

(e) incorporate a four-position selector switch/ from which single phase/three phase/single and three phase auto reclosure and non- auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through programming.

(f) have facilities for selecting check synchronising or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.

(g) be of single shot type.

(h) have priority circuit to closing of both circuit breakers in case one and half breaker arrangements to allow sequential closing of breakers

(i) be acceptable as built in with line distance relay for 132 KV

(j) include check synchronising relay which shall

- have a time setting continuously variable between 0.5-5 seconds. with a facility of additional 10 seconds.
- have a response time within 200 milli seconds with the timer

disconnected.

- have a phase angle setting not exceeding 35 degree
- have a voltage difference setting not exceeding 10% (k) include dead line charging relay which shall
- have two sets of relays and each set shall be able to monitor the three phase voltage where one set shall be connected to the line CVTs with a fixed setting of 20% of rated voltage and the other set shall be connected to the bus CVTs with a fixed setting of 80% of rated voltage.
- incorporate necessary auxiliary relays and timers to give comprehensive scheme.

19. **LINE OVER VOLTAGE PROTECTION RELAY** shall

(a) monitor all three phases

(b) have two independent stages and stage- 1 & II relay are acceptable as built in with line distance relays Main I & II respectively .

(c) have an adjustable setting range of 100-170% of rated voltage with an adjustable time delay range of 1 to 60 seconds for the first stage.

(d) have an adjustable setting range of 100-170% of rated voltage with a time delay of 100-200 mill seconds for the second stage.

(e) be tuned to power frequency

(f) provided with separate operation indicators (flag target) for each stage relays.

(g) have a drop-off to pick-up ratio greater than 95%.

(h) provide separate out-put contacts for each 'Phase' and stage for breaker trip relays, event logger and other scheme requirements.

21. **FLAG RELAYS**

These shall have

(a) hand reset flag indication

(b) have minimum two contacts (NO or NC or combination as required) for each relay

22. **TRIP CIRCUIT SUPERVISION RELAY**

(a) The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.

(b) The relay shall have adequate contacts for providing connection to alarm and event logger.

(c) The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

23. DC SUPPLY SUPERIVISION RELAY

(a) The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.

(b) It shall have adequate potential free contacts to meet the scheme requirement.

(c) The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

24. WEATHER PROOF RELAY PANELS

(a) This panel shall include necessary number of electrically reset relays each with at least eight contacts for isolator auxiliary contacts multiplication and for changing the CT and DC circuits to relevant zones of bus bar protection.

(b) The panel shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be at least 2.0 mm thick and properly braced to prevent wobbling.

(c) The enclosures of the panel shall provide a degree of protection of not less than IP-55 (as per IS:2147).

(d) The panel shall be of free standing floor mounting type or pedestal mounting type as per requirement.

(e) The panel shall be provided with double hinged doors with padlocking arrangement.

(f) All doors, removable covers and panels shall be gasketed all around with synthetic rubber gaskets Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh

(g) Cable entries shall be from bottom. Suitable removable cable gland plate

shall be provided on the cabinet for this purpose.

(h) All sheet steel work shall be degreased, pickled, phosphated and then applied with two coats of zinc chromates primer and two coats of finishing synthetic enamel paint, both inside and outside. The colour of the finishing paint shall be light grey in accordance with shade no.697 of IS:5.

(i) Suitable heaters shall be mounted in the panel to prevent condensation. Heaters shall be controlled by thermostats so that the cubicle temperature does not exceed 30^{o}C. On-off switch and fuse shall be provided. Heater shall be suitable for 240V AC supply Voltage.

(j) The test terminal blocks (TTB) to be provided shall be fully enclosed with removable covers and made of moulded, non-inflammable plastic material with boxes and barriers moulded integrally. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.Terminal block shall have shorting,disconnecting and testing facilities for CT circuits.

25. TYPE TESTS

25.1. The reports for following type tests shall be submitted by the bidder for the Protective relays, Fault locator, Disturbance recorder and Event Logger

a) Insulation tests as per IEC 60255-5

b) High frequency disturbance test as per IEC 60255-4 (Appendix -E) - Class IV (not applicable for electromechanical relays)

c) Fast transient test as per IEC 1000-4, Level IV(not applicable for electromechanical relays)

d) Relay characteristics, performance and accuracy test as per IEC 60255

- Steady state Characteristics and operating time
- Dynamic Characteristics and operating time for distance protection relays and current differential protection relays.

For Distrubance recorder and Event logger only performance tests are intended under this item.

e) Tests for thermal and mechanical requirements as per IEC 60255-6

f) Tests for rated burden as per IEC 60255-6

g) Contact performance test as per IEC 60255-0-20 (not applicable for Event logger, Distance to fault locator and Disturbance recorder)

25.2 Steady state & Dynamic characteristics test reports on the distance protection relays, as type test, shall be based on test programme specified in Appendix A on simulator/network analyser/PTL. Alternatively, the files generated using Electromagnetic transient Programme (EMTP) can also be used for carrying out

the above tests. Single source dynamic tests on transformer differential relay shall be/ should have been conducted based on general guidelines specified in CIGRE committee 34 report on Evaluation of characteristics and performance of Power system protection relays and protective systems.

26. CONFIGURATION OF C&R PANELS

The following is the general criteria for the selection of the equipments to be provided in each type of panel.

CONTROL PANEL

Various types of control panels shall consist of the following

a	CB Control switc	1 no.	for each Circuit breaker
b	Isolator Control switch	1 no	for each isolator
c	Semaphore	1 no.	for each earth switch
d	Red indicating lamp	1 no.	for each Circuit breaker
e.	Red indicating lamp	1 no.	for each isolator
f	Green indicating lamp	1 no.	for each Circuit breaker
g	Green indicating lamp	1 no.	for each isolator
h	White indicating lamp (DC healthy lamp)	2 nos	for each feeder
i	Annunciation windows with relays	18 no	for each feeder associated annunciation
j	Push button for alarm Accept/reset/lamp test	3 nos	for each control panel
k	Mimic to represent SLD	Lot	in all control pan
l	HT Electronic Energy meter of 0.2 class	1 No	1 No. for line panels & Bus coupler Panel, 2 No.for Transformer panels i.e. 1 No. each HV & LV as per the specification of Board

1. In case of incomplete diameter (D and I type layouts), control panel shall be equipped fully as if the diameter is complete, unless otherwise specified. Annunciation relays shall also be provided for the same and if required, necessary panel shall be supplied to accommodate the same.

2. The above list of equipments mentioned for control panel is generally applicable unless it is defined elsewhere .

3. Each line /HV side of transformer/MV/LV side of transformer /Bus reactor /TBC /BC/ Bus Section shall be considered as one feeder for above purpose.

LINE PROTECTION PANEL

The Line Protection panel for transmission lines shall consist of following relays and protection schemes

Sl No.	Description	132 KV
1	Main 1 Numerical Distance Protection scheme	1 set
2	Distance to fault Locator	(Part of feature
3	3 phase trip relays (Hand reset)	1no.
4	Flag relays , carrier receive relays ,aux. Relays timers etc	Lot
5	Under voltage relay for isolator /earth switch	2nos
6	Cutout & wiring with TTB for energy meter	1 set
7	Directional back up over current and E/F Protection Scheme	1 set
8	D.C. Supply supervision Relay	2 Nos.
9	Trip Ckt Supervision Relay	2 Nos.

27. ERECTION AND MAINTENANCE TOOL EQUIPMENTS

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule

28. TROPICALISATION

All equipments shall be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to tropical environment.

4 PLCC

1. GENERAL

1.1 All the PLCC equipment covered under the package shall conform to the requirements of the latest edition of the relevant IEC/IS Specifications or equivalent National Standards,

2. Standard And Drawing

2.1 The IEC/IS Specifications and international publication relevant to the equipment covered under this specification shall include but not be limited to the description given at Section - GTR:

3. Location of Equipment

3.1 The PLCC Equipment and Line traps as specified shall be installed at the respective ends of the transmission lines. The Contractor shall be responsible for coordinating the equipment supplied by him with the already existing carrier equipment at the respective sub-stations. Contractor shall also be responsible for collecting all the necessary information/data from the respective sub-stations for the installation of the equipment.

4. Frequency Planning

4.1 For planning frequency and output power of carrier terminals Bidders may plan for a minimum receive signal to noise ratio of 25 dB for the speech channels without companders. The noise power in 2.1 kHz band (300-2400 Hz) may be taken as -13 dBm referred to the coupling point of the H.T. line. An additional minus two and a half dB may be assumed for psophometric factor. As far as coupling loss (phase to phase) is concerned the Bidders may assume the same as 6dB at one coupling end for evaluating SNR. For protection channels the minimum SNR shall not be less than 15 dB under adverse weather. A safety margin of 9 dB shall be taken over and above these SNR values in order to cater for variations in line attenuation from the computed value as inhand reserve. Frequency and output power of PLC terminals for protection shall be planned such that the protection signal is received with full reliability even when one of the phase is earthed or is on open circuit on the line side causing an additional minimum loss of 6 dB.

The Bidder shall indicate the noise power in the bandwidth used for protection signaling and shall submit the SNR calculations for speech as well as protection channels on all the line section given in at the proposed frequencies. Sample calculations for SNR requirement and power allocation over different channels must be furnished alongwith the bid. Maximum permissible line attenuation shall be clearly brought out in these calculations. Further, Bidder shall submit details of frequency planning done (including computer studies carried out and facilities available) for PLCC links on EHV lines in the past in the relevant schedule of DRS. Bidder must enclose one copy of computer study result done in the past along with the Bid.

4.2 Successful Bidder shall be fully responsible for the coordination required finalising the frequency plan.

4.3 The frequency plan will be referred to wireless Adviser/DOP Department for clearance and in case any change in the Contractor's recommended carrier frequency and power output is proposed by these authorities, the Contractor shall have to modify his proposal accordingly. Change of power output shall, however, not involve repeater stations.

5. Proposed Arrangement

5.1 132kV transmission lines shall have Main I protection same as above alongwith backup over current and earth fault protections.

5.2 The requirement of carrier information on each link covered under this specification is as below :

For 132 KV lines ,speech and data channel can also be used for protection wherever possible.

One speech channel with a facility to superimpose data signals upto 1200Baud.

However, the number of channels for protection signaling , speech and data communication for SAS and Load dispatch centre shall be as per the requirement of BSEB.

5.3 The equipment for protection signals shall have high degree of reliability and speed. It shall be guaranteed to function reliably in the presence of noise impulse caused by isolator or breaker operation. The equipment shall be suitable for direct tripping of remote end breaker for fault in unswitched Shunt Reactor & Operation of Buchholz relays of reactor etc. It shall also be possible to effect direct tripping of breaker at one end when the other end breaker opens out either manually or by relays such as Bus fault relay etc.

5.4 The time intervals between receipt of a trip command on the transmit side, its transmission over the carrier link, reception at the far end and giving command to the trip relays at the distant end shall not exceed 20 mS. for permissive inter- tripping and 30 m sec. for direct inter-tripping even for the longest line section. The above timings are inclusive of operating time for auxiliary relays and interposing relays,

if any, included in the PLCC equipment.

5.5 The requirement of protection signaling channel is such that security against incorrect signals being received shall be at least two to three orders higher than reliability against a signal not being received.

5.6 For reasons of security and reliability, phase to phase coupling shall be employed. Double differential coupling shall also be considered for double circuit lines. Bidders must furnish detailed write-up on methods of coupling and recommend suitable coupling mode for double-circuit lines along- with the bids.

5.7 The Contractor shall have to check and prove through the results of his computer studies that attenuation due to transpositions in the EHV lines is within limits and the offered equipment will perform satisfactorily.

5.8 The Bidder shall submit curves illustrating 'incorrect tripping' and "Failure to trip" probability plotted against corona noise level, in the presence of impulse noise due to switching of isolator and circuit breaker etc. Details of field tests and laboratory tests for successful operation of his equipment, under such adverse conditions shall be furnished by the Bidder. These are to be related to end-to-end signaling and shall take into account the type of communication link e.g. account shall be taken of transpositions in the phase to phase coupled H.T. line. Details of field tests and laboratory tests for successful operation of the equipment under the above circumstances shall be submitted by the Bidder illustrating the above parameters.

6. LINE TRAP

6.1 Line trap shall be broad band tuned for its entire carrier frequency range. Resistive component of impedance of the line trap within its carrier frequency blocking range shall not be less than 570 ohms for 220kV and 132 kV systems..

6.2 Line trap shall be provided with a protective device in the form of surge arrestors which shall be designed and arranged such that neither significant alteration in its protective function nor physical damage shall result from either temperature rise or the magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation, following transient actuation by the power frequency voltage developed across the line trap by the rated short time current.

The lightning arrestor shall be station class current limiting active gap type. Its rated discharge current shall be 10 kA. Coordination, however, shall be done by taking 20 kA at 8/20 micro-sec. discharge current into account. Bidder has to furnish full justification in case the use of gap-less metal oxide arrestor is recommended by them.

6.3 The lightning arrestor provided with the line trap of each rating shall fully comply with the requirements of IS:3070 Part-I/IEC-60099-I Part-I. It shall conform to type tests as applicable and type test certificate for the same shall be submitted by the Bidder.

6.4 The lightning arrestor provided with the line trap shall be subject to routine and acceptance tests as per IEC-60099-1 (Part-I).

6.5 Radio interference voltage for 132 kV shall not exceed 500 micro volts at 163/97 kV (rms) respectively.

6.6 Line trap shall be equipped with the bird barriers.

6.7 Line trap shall conform to IEC 60353 (latest) fulfilling all the technical requirements. The rated short time current for 1 Second shall be 31.5 kA as per requirement.

6.8 The Bidder shall indicate continuous current rating of the line trap at 65 deg. C ambient.

6.9 Reports for the following type tests on each type of line trap shall be submitted as per GTR .

1. Measurement of Inductance of the main coil.
2. Measurement of temperature rise.
3. Insulation test.
4. Short time current test.
5. Corona Extinction Voltage test (procedure for this shall be mutually agreed).
6. Radio Interference Voltage measurement test (procedure for this shall be mutually agreed).

6.10 The Bidder must enclose with his bid the reports of type and routine tests conducted on similar equipment earlier as per IEC-60353.

6.11 Welding

All the welding included in the manufacture of line traps shall be performed by personnel and procedure qualified in accordance with ASME-IX and all the critical welds shall be subject to NDT as applicable.

6.12 Line Trap Mounting

6.12.1 The Line Trap shall be suitable for outdoor pedestal or suspension mounting and shall be mechanically strong enough to withstand the stresses due to maximum wind pressure of 260 kg/square meter.

6.12.2 For pedestal mounting, each line trap shall be mounted on a tripod structure formed by three insulator stacks arranged in a triangular form. All the accessories and hardware, mounting stool including bolts for fixing the line trap on insulators shall be of non-magnetic material and shall be supplied by the Contractor.

6.12.3 For suspension mounting, Contractor shall be required to coordinate the mounting arrangement with the existing arrangement. Non-magnetic suspension hook/link of adequate length and tensile strength to provide necessary magnetic clearance between the line trap and suspension hardware shall be supplied by the Contractor.

6.13 Terminal Connectors

6.13.1 The line traps shall be suitable for connecting to ACSR single/twin panther conductor with horizontal or vertical take off. Necessary connector shall be supplied by the Contractor.

6.13.2 Terminal Connectors shall conform to IS:5561.

6.13.3 No part of clamp or connector (including hardware) shall be of magnetic material.

6.13.4 Radio interference Voltage for 132 kV shall not exceed 500 microvolts at 97 kV (rms) respectively.

6.13.5 Clamps/connectors shall be designed for the same current ratings as line trap and temperature rise shall not exceed 35 deg. C over 50 deg. C ambient. No current carrying part shall be less than 10 mm thick.

6.13.6 Clamps/connectors shall conform to type test as per IS:5561.

6.13.7 Bidders are required to submit alongwith their bid typical drawings clearly indicating the above mentioned features of the line traps, line trap mounting arrangement and terminal connectors. For suspension mounted line traps, Bidder shall submit drawings showing single point as well as multipoint (normally 3 point) suspension arrangements.

7. COUPLING DEVICE

7.1 The coupling devices shall be interposed between the capacitor voltage transformer and coaxial line to the PLC transmitter/receiver, and in conjunction with the capacitor voltage transformer shall ensure :

a) Efficient transmission of carrier frequency signals between the carrier frequency connection and the power line.

b) Safety of personnel and protection of the low voltage parts and installation, against the effects of power frequency voltage and transient over voltages.

7.2 The coupling device, in conjunction with the CVT shall from an electric filter of band pass type :

a) It shall match characteristic impedance of H.T. line to impedance of the carrier frequency connection.

b) Galvanic isolation between primary and secondary terminals of the coupling device shall be performed by the above mentioned transformer.

c) Power frequency currents derived by the CVT may be drained to the earth by a separate inductance termed drain coil of suitable rating.

d) Voltage surges coming from the power line at the terminals of the coupling device shall be limited by a non-linear surge arrestor of suitable rating

in the primary side. Requirement of a gas type voltage arrestor in secondary side of the coupling device shall have to be fully justified, but in any case the input circuit of PLC. equipment shall have protective devices in the form of zener diodes and surge suppressers. The surge arrester shall have power frequency spark over voltage coordinated with the equipment ahead of it.

e) For direct and efficient earthing of its primary terminals, the coupling device shall be equipped with an earthing switch. The Earth Switch shall be available for earthing of CVT-HT terminals, when the coupling filter units are removed from circuit for maintenance/ replacement. The design shall take due regard of requirements for safety in accordance with the Indian Electricity Rules.

7.3 Two numbers 'phase to earth' type coupling filters shall be used to achieve 'phase to phase'/ 'inter-circuit coupling'. Connection between secondaries of the two phase to earth type coupling device shall be through a balancing transformer/hybrid such that reliable communication shall be ensured even when one of the coupled phase is earthed or open circuited on the line side.

7.4 Coupling device shall conform to IEC-60481 and shall have the following carrier frequency characteristics as applicable to a phase to earth type coupling device:

a)	Nominal line side impedance	400 ohms for 220/132 kV line
b)	Nominal equipment side impedance	75 ohms (unbalanced)
c)	Composite loss	Not more than 2 dB
d)	Return Loss	Not less than 12 dB
e)	Bandwidth	Shall suit the frequency plan between 36 and 500 kHz
f)	Nominal peak envelope Power (for Inter-modulation product 80 dB down)	Not less than 650 Watt.

7.5 The coupling device shall be suitable for outdoor mounting. Temperature of metallic equipment mounted outdoor is expected to rise upto 65 deg. C during the maximum ambient temperature of 50 deg. C specified. The equipment offered by the Bidder shall operate satisfactorily under these conditions.

7.6 The H.T. Terminal of coupling device shall be connected to H.F. Terminal of the CVT by means of 6 mm sq. copper wire with suitable lugs & taped with 11 kV insulation by the contractor.

7.7 Coupling device shall have at least two terminals for carrier equipment connection. Bidder shall confirm that such a parallel connection to coupling device directly will not result in any additional attenuation.

7.8 The coupling device including the drainage coil, surge arrester and earthing switch shall conform to type tests and shall be subject to routine tests as per IEC-60481/IS:8998.

Routine tests shall include but not be limited to the following :

i) Composite loss and return loss tests on coupling device.

ii) Turns ratio test and insulation tests on the balancing transformer.

iii) Milli volt drop test, power frequency voltage test and mechanical operation test on earthing switch.

iv) Power frequency spark over test for lightning arrester as per relevant IS/IEC.

7.9 Reports for the following type tests on coupling device shall be submitted as per GTR .

1.) Return loss test.

2.) Composite loss test.

3) Distortion and inter modulation test .

4) Impulse voltage test.

5) Tests on Arrestors

Bidder shall furnish, alongwith his bid copies of all type and routine test conducted earlier on similar coupling device in accordance with relevant standards.

8. High Frequency Cable

8.1 High frequency cable shall connect the coupling device installed in the switchyard to the PLC terminal installed indoor.

8.2 The cable shall be steel armoured and its outer covering shall be protected against attack by termites. Bidder shall offer his comments on method employed by him for earthing of screen and submit full justification for the same with due regard to safety requirements.

Bidder must enclose in his bid a detailed construction drawing of the cable being offered, with mechanical and electrical parameters.

8.3 Impedance of the cable shall be such as to match the impedance of the PLC terminal on one side and to that of the coupling device on the other side over the entire carrier frequency range of 40-500 kHz.

8.4 Conductor resistance of cable shall not exceed 16 ohms per Km at 20°C.

8.5 The cable shall be designed to withstand test voltage of 4 kV between conductor and outer sheath for one minute.

8.6 Bidder shall specify attenuation per Km of the cable at various carrier frequencies in the range of 40 to 500 kHz. The typical attenuation figures for H.F. cable shall be in the range of 1 to 5 dB/km in the frequency range of 40-500 kHz.

8.7 The H.F. cable shall conform to type tests and be subjected to routine tests as per IS 11967(Part 2/Sec 1): 1989/IS 5026:1987.

8.8 All HF cables within the scope of this specification shall be laid and termination shall be carried out by the Contractor.

8.9 The cables shall be supplied wound on drums containing nominal length of 500 meters each. However, exact requirement of drum lengths shall be finalised during detailed engineering to avoid joint in HF cable and its wastage.

9. Power Line Carrier Terminal

9.1 As already indicated the information link shall be provided for speech, protection, telex and data services.

9.2 PLC terminal shall use Amplitude Modulation and shall have single side band transmission mode. These shall be equipped for fixed frequency duplex working.

Characteristic input and output parameters of the SSB PLC terminals shall be as per IEC-60495, unless otherwise specified.

9.3 The salient features are detailed out below :

a)	Mode of transmission	Amplitude Modulation single side band with suppressed carrier or reduced carrier.
b)	Carrier frequency	40 to 500 kHz range
c)	Nominal carrier frequency band in either direction of transmission	4.0 kHz
d)	Power output (PEP) HF terminal	20/40/80 Watt at
e)	Frequency difference between a pair of PLC terminals	Frequency difference between VF signal at the transmitting and receiving ends will not exceed 2 Hz with suppressed carrier. With reduced carrier frequency difference shall be zero. This shall include permissible ambient temperature variation and supply frequency and voltage variation of (+) 15% and (-) 10%.

f)	Automatic gain control	For 40 dB change in carrier frequ ncy signal level within the regulation range, change in VF receive levels of both speech and other signals shall be less than 1dB.
g)	Supply voltage	48 V DC + 15%, - 10%. (Positive pole earthed)

9.4 All the PLC terminals shall be of multipurpose type. The Bidder shall confirm that the total transmission time for teleprotection shall not exceed 20 ms for permissive and 30 ms for direct tripping signals. Speech and teleprotection channels shall independently fulfill the SNR requirements out of the power allocated to its channel from the total power of the PLC terminals.

Detailed calculation for SNR requirement and power allocation over different channels should be furnished alongwith the bid.

9.5 In the input circuit of the PLC terminal protective devices shall be provided in the form of zener diodes or surge suppressers in order to eliminate any surge transfer through the coupling device or the surge induced in the connecting path of H.F. cable.

9.6 To improve voice transmission characteristics for the system, compressors and expanders shall be provided. The companders shall have at least 2:1 compression ratio with a corresponding expansion ratio of 1:2. The operating range of compander shall be compatible with the audio power levels specified for 4 wire operation. The improvement gained by companders shall however not be taken into account for power allocation and shall be in-hand reserve.

9.7 Sudden changes in input level to the receiver shall not cause false tripping. The Bidder shall clearly indicate in his offer the methods adopted to ensure above phenomenon. The receiver design shall also provide protection against false tripping from random noise.

9.8 Fail-safe devices shall be provided, so that a malfunction in one unit or subassembly cannot cause damage elsewhere in the system. All plug-in equipment shall be fitted with features to prevent improper insertion. The electrical cables shall not be routed across sharp edges or near sources of high temperature. The adjustments, which are susceptible to misadjustment from accidental contact/vibration, shall be equipped with suitable locking devices.

9.9 The PLC set shall be designed to give guaranteed performance from 0 deg. C to 50 deg. C ambient temperature. The thermal capability of the equipment shall be so designed that the equipment remains operational successfully upto 60 deg. C ambient temperature. Any ventilation fans provided for circulation of air inside the cabinets shall conform to relevant Indian Standards.

9.10 The terminals shall be provided with built-in indicating instrument to facilitate checking of important voltages and current values and signal levels in different parts of the PLC Terminals. Protection fuses shall be provided in all important circuits and fuses shall be so mounted as allow their easy inspection and replacement. All test

points shall be easily accessible.

The carrier set shall be provided with suitable supervision and alarm facilities. Individual parts of the carrier set should be accessible from front, making it possible to place the carrier cabinets side-by-side. All components and parts of the carrier set shall be suitably tropicalised.

9.11 PLC terminals shall be housed in floor mounting sheet metal cabinets, suitable for mounting on concrete plinth as well as channel frame by means of nuts and bolts or welding. All the panels shall be properly earthed to the OWNER's earthing grid by the Contractor. Contractor shall submit detailed drawings for earthing connections.

9.12 All the panels shall be protected against moisture ingress and corrosion during storage. Panels shall be properly dried before they are installed and energized.

Bidder shall indicate measures adopted to prevent ingress of moisture during operation.

9.13 All cabinets having PLC terminals shall be provided with lamps of sufficient wattage for interior illumination with switch. Each panel shall be provided with 240 V AC single phase socket with switch to accept 5 & 15A standard Indian plugs.

9.14 A name plate shall be provided on the front door of each cabinet indicating channel function, transmitter frequency and direction etc.

9.15 Reports for the following type tests for PLC Terminals shall be submitted as per GTR . Tests to determine various characteristics of PLC terminals as per IEC –60495.

a) Voltage variation

b) Carrier frequency range band.

c) Frequency accuracy

d) Transmit/Receive frequency difference.

e) Automatic gain control

f) Harmonic distortion

g) Selectivity

h) Output impedence, Return loss&Tapping loss

i) Return loss, Afinputs/Outputs

j) Balance to ground

k) Limiter action

l) Spurious emission

m) Carrier frequency levels and levels

n) Attenuation distortion

o) Noise generated within terminal

p) Near and far end cross talk

q) Group delay distortion

r) Conducted noise

s) Telephone signaling channel

t) Speech levels

u) Voltage withstand test

v) Insulation test

9.16 Heat Soaking of panels

All the solid state equipment/system panels shall be subjected to the Heat Soaking as per the following procedure :

All solid state equipment shall be burn-in for minimum of 120 hours continuously under operation condition. During the last 48 hours of testing, the ambient temperature of the test chamber shall be 50°C. Each PLC panel shall be complete with all associated sub-systems and the same shall be in operation during the above test. During the last 48 hours of the above test, the temperature inside the panel shall be monitored with all the doors closed. The temperature of the panel interior shall not exceed 65°C.

10. SPEECH COMMUNICATION

10.1 PLC equipment offered shall provide telephone communication between the stations where the transmission lines are terminating. The equipment shall be suitable for providing the following facilities :

a) It shall be possible for subscriber at any of the stations to contact the subscriber at all other stations connected in the system as shown in the specification drawing by dialing his call number. To achieve this a 24 lines EPAX with 4 wire interface & remote subscriber units shall be provided/available at different stations.

b) The equipment shall contain all normal facilities like ring back tone, dial tone, engage tone & priority tone, and suitable pulses to establish and disconnect communication between subscribers.

c) The equipment shall be provided with necessary alarm circuits and fuses etc.

d) The equipment shall be of 4 kHz bandwidth on either direction and be suitable for providing superimposed data and teleprinter facilities at a later date without major modifications and high cost. The Bidder shall clearly indicate in his bid the provision made in his proposal for future development and the extent to which such additional facilities can be added at a later date.

e) The system shall be completely automatic with definite number allocated for each telephone. The numbering scheme for telephones, exchange and tie lines shall be developed by the Bidder and indicated in the bid. Final numbering scheme shall be fully coordinated with the existing/ proposed future systems by the Contractor.

f) Arrangement for over-riding facilities shall be provided by means of priority keys wherever specified. The over-riding facility shall enable cutting-in ongoing calls with the priority key and ask the concerned parties to finish their conversation. The wanted number should then get automatically connected without having to redial the number.

g) All the carrier telephone conversations shall be secret and it should not be possible for anybody to over hear the conversation going on between any two parties excepting those provided with over-riding facilities.

h) The necessary cables for connecting all the telephone instruments ordered for at each sub-station (including wiring and termination) shall be provided by the Contractor. These telephone instruments shall be located within control room building at respective sub-station.

i) The cabinets housing the equipment for EPAX, four wire E/M interface & remote subscriber units (four wire) shall have mounting arrangement similar to that for PLC terminals.

j) All the terminals for speech shall be with Transit Band Pass Filter suitable for tuning at site and shall be wired for addition of VFTs in future.

k) Equipment for speech communication must be fully compatible with OWNER's existing equipment. Any interfaces required for proper matching and connection with the OWNER's existing equipment shall be provided by the Contractor.

l) Terminals for protection shall be suitable for speech between two ends of each transmission line or on tandem operation basis with back to back connection at the intermediate stations.

n) Each PLC terminal for speech as well as protection purposes shall be provided with a plug-in type service telephone and buzzer. Further, 4 wire remote telephone instruments (parallel to service telephone) shall also be provided on one PLC terminal for protection for each link. These instruments shall be located in respective Switchyard control room to enable

the operator to make emergency calls on point-to-point basis. Each such instrument shall be equipped with a buzzer and 'press-to-call' key and shall not require any additional power supply units.

10.2 Network Protection Equipment (Protection Coupler)

10.2.1 The Bidder shall offer voice frequency transmission equipment which shall work on frequency shift or coded signal principle for transmission/reception of protection signals as single purpose channel. The equipment shall be suitable for connection to the power line carrier terminal.

10.2.2 The voice frequency transmission equipment shall not only be insensitive to corona noise but shall also remain unaffected by impulse type noise which are generated by electrical discharge and by the opening and closing of circuit breakers, isolators, earthing switches etc. The equipment shall also be made immune to a field strength of 10V/m expected to be caused by portable radio transmitters in the range of 20-1000 MHz. In his offer, bidder shall clearly explain as to what measures have been taken to make the equipment insensitive to corona noise, white noise and to impulse noise of an amplitude larger than the wanted signal and submit full field test and laboratory test reports. The guarantee on design data shall not be acceptable.

10.2.3 The equipment shall be unaffected by spurious tripping signals. The Bidder shall submit proof as to how this is achieved satisfactorily.

10.2.4 The equipment shall be suitable for transmission of direct and permissive trip signal as well as blocking signals for protective gear of power system. The equipment shall be operated in the audio frequency range in speech band or above speech band as superimposed channel in 4 kHz band of SSB carrier. The equipment shall operate with full duplex frequency shift mode of operation or by switching between two frequencies in case of coded signals . The protection signaling equipment shall be of solid state design, modular in construction and have a proven operating record in similar application over EHV systems. Details regarding application of the equipment over 765kV/400kV/220kV systems shall be submitted along with the bid. Each protection signaling equipment shall provide:

i) Transmission facilities for minimum three protection signals.
ii) Reception facilities for minimum three protection signals.

10.2.5 The equipment shall be designed for remote tripping/ blocking on permissive basis and direct tripping for reactor fault and others. The overall time of PLC,VFT and transmission path for permissive trip/blocking shall be 20 m. Sec. or less and for direct tripping 30 m. Sec. or less even for the longest line section.Operating time lower than specified above may be preferred provided they fulfill the requirements of security and

reliability as mentioned below :

False - trip probability 10^{-5} (Noise burst of any amplitude)

Fail to trip probability 10^{-2} for

S/N 6 dB in 3.1 kHz Band
(white Noise Measurement)

10.2.6 It may be emphasized that specified time, as mentioned above is composed of the following :

a) Back-to-back signal delay in frequency shift or coded signals protection equipment.

b) Back-to-back delay inPLCterminal

c) Delay in transmission line.

d) Operation time of interposing relay, if any, in frequency shift or coding equipment.

Reference is invited in this regard to the guide lines expressed in CIGRE Publication "Teleprotection" report by Committee 34 and 35.

10.2.7 The following transfer criteria shall be provided by the equipment:

a) Transmit side

One number potential free NO (normally open) contact of protective relays (To be supplied by the OWNER) of under noted rating for each of the following functions:

i) Permissive trip command

ii) Direct trip command

Contact Rating:

Maximum voltage	: 660 Volts
Maximum current rating	: 5 amps Maximum
power rating	: 1250 W/VA

b) Receive Side

Voice frequency transmission equipment for network protection shall be provided with one potential free NO (normally open) contact of the under noted rating for each of the following functions:

i) Permissive trip command

ii) Direct trip command

Contact Rating:

Rated voltage : 250 Volts DC Rated

current	:	0.1 A DC
Other Parameters	:	As per IEC-60255-25

c) Alarm

In addition, the voice frequency protection terminal shall provide at least one number potential free change over contact of the following rating for alarm purposes.

Rated voltage	:	250 volts DC Rated
current	:	0.1 A DC
Other Parameters	:	As per IEC-60255-25

10.2.8 The Contractor shall submit drawings showing inter-connection between PLCCAnd protection panels for approval by the OWNER.

10.2.9 It has to be ensured that under no circumstances protection channel should share the power. Each protection channel shall be able to transmit power for which system is designed. For example, a 40 W PLC terminal shall transmit 40 Watt (max.) for protection channel alone in the event of fault. Speech and super- imposed data channels, in the same protection terminal must get disconnected momentarily during the operation of protection channels.

10.2.10 The equipment shall be constructed such that in permissive line protection system, operational reliability of the protection channel may be checked over the carrier link by means of a loop test. It shall be possible to carry out the above test from either end of the carrier link. During healthy condition of the transmission line, the loop test shall not initiate a tripping command. In the event of a system fault, while loop test is in progress, protection signal shall over-ride the test signal

10.2.11 The equipment shall be complete with built in counters for counting the number of trip commands sent and number of trip commands received.

10.2.12 Reports for the following tests shall be submitted for approval for protection coupler and the relays associated with PLCC equipment for network protection signaling equipment and interface unit with protective relay units if any :

1) Protection coupler (As per IEC 60834 -1)

a) Power supply variation

b) Power supply interruption

c) Reflected noise

d) Reverse polarity

e) Interference by discrete frequency

f) Transmission time

g) Interference by frequency deviation. (Wherever applicable)

h) Alarm function

i) Security

ii) Dependability

i) Voltage withstand test

j) Insulation test.

k) Electrical fast transient test (along with carrier terminal)

l) HF disturbance test (along with carrier terminal)

m) Electro static discharge test (along with carrier terminal)

n) Radiated electromagnetic field susceptibility test (along with carrier terminal)

o) Environment test (as per IS: 9000)

2. **Relays.**

a) Impulse voltage withstand test as per Clause 5.1 of IS:8686 (for a test voltage appropriate to Class III as per Clause 3.2 of IS:8686).

b) High Frequency Disturbance test as per Clause 5.2 of IS:8686 (for a test voltage appropriate to Class III as per Clause 3.2 of IS:8686).

12. LIST OF COMMISSIONING TESTS

The following tests shall be carried out on complete system/subsystem during commissioning:

1. Composite loss and return loss on coupling device using dummy load.

2. Composite loss (Attenuation) for HF Cable coupling device.

3. End to end attenuation measurement for verification of optimum coupling mode. Test shall be done for all combinations.

4. End to end return loss for optimum coupling mode.

   a). open behind line trap.

   b). grounded behind line trap.

5. If end to end return loss for optimum coupling mode is not satisfactory, same shall be measured for other coupling modes also.

6. Adjustment of Tx /Rx levels on PLCC equipment as per test schedule.

7. AF frequency response (end to end) for the entire 4 kHz Bandwidth for speech and teleportation channels.

8. Measurement of noise in 2 kHz bandwidth with and without line energized.

9. SNR (test-one) with line energized noting down weather conditions.

10. Transmission time for teleportation and other data channels.

11. Observation of Tx /Rx levels (test-tone) for each channel at both ends by sequential switching on/off parallel channels using dummy load and also with the transmission line.

12. Observation of end to end and trunk dialing performance.

13. Observation of end-to-end protection signaling (command sent & received) in conjunction with protective relays, noting down transmission/receipt of unwanted commands under switching operations in the switchyard during protective relay testing.

Notes

1. All measurements for link attenuation, composite loss and return loss shall be carried out for the entire range of carrier frequencies with specific attention to the frequencies.

   i. Within coupling device bandwidth.

   ii. Within line trap bandwidth, and

   iii. Operating frequencies.

2 Following tests shall be carried out independently at each end

   i. Composite loss & return loss for coupling device.

   ii. Attenuation test for HF cable + coupling device.

   iii. Levels and other local adjustments (on dummy load).
   Final adjustment shall be on end to end basis.

   iv. Test for loading by parallel channels with dummy load.
   This test can be done alongwith tests for coupling device.

   v. Protection signaling under local loop test (dummy load).

3 Necessary test instruments required for all the above tests shall be brought by commissioning engineers of the contractor

5 SPECIFICATION FOR CIRCUIT BREAKERS

1.0 GENERAL

1.1 The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 60694 and other relevant IEC standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in specification, 145 kV circuit breakers offered would be of Sulphur Hexafluoride (SF6) type only and of class C1-M1 as per IEC. The bidder may also offer circuit breakers of either live tank type or dead tank type of proven design.

1.2 The circuit breaker shall be complete with terminal connectors, operating mechanism, control cabinets, piping, inter pole cable, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanized support structure for CB and control cabinets, their foundation bolts and all other circuit breaker accessories required for carrying out all the functions the CB is required to perform.

1.3 All necessary parts to provide a complete and operable circuit breaker installation such as main equipment, terminals, control parts, connectors and other devices whether specifically called for herein or not shall be provided.

1.4 The support structure of circuit breaker as well as that of control cabinet shall be hot dip galvanised. All other parts shall be painted as per shade 697 of IS -5.

1.5 The circuit breakers shall be designed for use in the geographic and meteorological conditions as given in specification.

1.1 DUTY REQUIREMENTS

2.0 The circuit breakers shall be capable of performing their duties without opening resistors.

2.1 The circuit breaker shall meet the duty requirements for any type of fault or fault location also for line switching when used on a 145 KV effectively grounded system, and perform make and break operations as per the stipulated duty cycles satisfactorily.

2.3 The breaker shall be capable of interrupting the steady state and transient magnetising current corresponding of power transformers.

2.4 The circuit breaker shall also be capable of:

i) Interrupting line/cable charging current as per IEC without use of opening resistors.

ii) Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

iii) Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.

2.5 The Breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energization of lines with trapped charges. The breaker shall also withstand the voltages specified under clause – 17. of this specification.

3.0 TOTAL BREAK TIME:

3.1 The total break time as specified under this Chapter shall not be exceeded under any of the following duties:

i) Test duties 1,2,3,4,5 (TRV as per IEC: 62271-100)

ii) Short line fault L75, L90 (- do -)

3.2 The Bidder may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage and arc extinguishing medium pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidders may specifically bring out the effect of non-simultaneity between contacts within a pole or between poles and show how it is covered in the guaranteed total break time.

3.3 The values guaranteed shall be supported with the type test reports.

4.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of circuit breakers shall be in accordance with requirements stated hereunder:

4.1 Contacts

4.1.1 The gap between the open contacts shall be such that it can withstand atleast the rated phase to ground voltage for 8 hours at zero gauge pressure of SF6 gas due to the leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. 2 p.u. across the breaker continuously).

4.2 If multibreak interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand of the grading elements shall be adequate for the service conditions and duty specified.

4.3 **The SF6 Circuit Breaker shall meet the following additional requirements:**

a) The circuit breaker shall be single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on the internal insulating surfaces of the circuit breaker.

b) All gasketted surfaces shall be smooth, straight and reinforced, if necessary, to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals. The SF6 gas leakage should not exceed 1% per year. In case the leakage under the specified conditions is found to be greater than 1% after one year of commissioning of circuit breaker, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during first year of operation after commissioning.

c) In the interrupter assembly there shall be an absorbing product box to minimise the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as fully compatible with SF6 gas decomposition products.

d) For CBs of voltage class of 145 kV or less, a common SF6 scheme/density monitor shall be acceptable.

e) The dial type SF6 density monitor shall be adequately temperature compensated to model the pressure changes due to variations in ambient temperature within the body of circuit breaker as a whole. The density monitor shall have graduated scale and shall meet the following requirements:

   i) It shall be possible to dismantle the density monitor for checking/replacement without draining the SF6 gas by providing suitable interlocked non return valve coupling.

f) Each Circuit Breaker shall be capable of withstanding a vacuum of minimum 8 millibars without distortion or failure of any part.

g) Sufficient SF6 gas including that will be required for gas analysis during filling shall be provided to fill all the circuit breakers installed. In addition spare gas shall be supplied in separate unused cylinders as per requirement specified.

4.4 Provisions shall be made for attaching an operational analyser after installation of circuit breakers at site to record contact travel, speed and making measurement of operating timings, preinsertion timings of closing resisters if used, synchronisation of contacts in one pole. In case operation

analyser is already available at a particular site, the contractor shall have to supply a suitable adapter/transducer so that the offered circuit breaker can be used with the operational analyser.

5.0 SULPHUR HEXAFLUORIDE GAS (SF6 GAS):

a) The SF6 gas shall comply with IEC 376, 376A and 376B and shall be suitable in all respects for use in the switchgear under the operating conditions.

b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the relevant standards and regulations.

c) Test: SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water content as per IEC 376, 376A and 376B and test certificates shall be furnished to Employer indicating all the tests as per IEC 376 for each lot of SF6 gas in stipulated copies as indicated in specification. Gas bottles should be tested for leakage during receipt at site.

6.0 INSULATORS:

a) The porcelain of the insulators shall conform to the requirements stipulated under specification.

b) The mechanical characteristics of insulators shall match with the requirements specified under this Chapter.

c) All insulators shall conform to IEC-61264 (for pressurised hollow column insulators) and IEC-233 (for others). All routine and sample tests shall be conducted on the hollow column insulators as per these standards with requirements and procedures modified as under:

   i) Pressure test as a routine test.

   ii) Bending load test as a routine test.

   iii) Bending load test as a sample test on each lot.

   iv) Burst pressure test as a sample test on each lot.

   v) In addition to above, ultrasonic test shall be carried out as additional routine test.

d) Hollow Porcelain for pressurised columns/chambers should be in one integral piece in green and fired stage.

7.0 Deleted

8.0 OPERATING MECHANISM AND CONTROL

8.1 General Requirements

8.1.1 Circuit breaker shall be operated by **spring charged mechanism.** The mechanism shall be housed in a weather proof and dust proof control cabinet as stipulated in specification.

8.1.2 The operating mechanism shall be strong, rigid, not subject to rebound and shall be readily accessible for maintenance for a man standing on ground.

8.1.3 The mechanism shall be antipumping and trip free (as per IEC definition) under every method of closing.

8.1.4 The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

8.1.5 A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.

8.1.6 Working parts of the mechanism shall be corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

8.1.7 The bidder shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker. The instruction manuals shall contain exploded diagrams with complete storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instructions.

8.2 Control:

8.2.1 The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.

8.2.2 Each breaker pole shall be provided with two (2) independent tripping circuits, pressures switches and coils each connected to a different set of protective relays.

8.2.3 The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However,

provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the Breaker central control cabinet.

8.2.4 The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker. The trip circuit supervision relay would be provided on relay panels.

8.2.5 Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coil and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage the breaker shall be able to open. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit breakers shall be clearly brought out in the additional information schedules.

8.2.6 Density Meter contacts and pressure switch contact shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuits shall be monitored and provision shall be made for remote annunciations and operation lockout in case of D.C. failures. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit Breaker.

8.2.7 The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

8.2.8 The preferred basic control schematic of the Circuit breaker is enclosed with the bid documents and it is expected to be followed by the bidder. This, however, does not absolve the bidder from the responsibility for safe and reliable operation of the breaker in its lifetime.

8.3 **Spring operated mechanism:**

a) Spring operated mechanism shall be complete with motor in accordance with specification. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual

charging of the closing spring shall also be provided. The motor rating shall be such that it requires not more than 30 seconds for full charging of the closing spring.

e) Closing action of circuit breaker shall compress the opening spring ready for tripping.

f) When closing springs are discharged after closing a breaker, closing springs shall be automatically charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.

h) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

9.0 SUPPORT STRUCTURE

a) The structure design shall be such that during operation of circuit breaker vibrations are reduced to minimum.

b) If required, the Contractor shall provide suitable platform with steps on both sides of the circuit breaker for easy accessibility for monitoring the density/pressure of gas.

10.0 TERMINAL CONNECTOR PAD

The circuit breaker terminal pads shall be made up of high quality electrolytic copper or aluminium. The terminal pad shall have protective covers which shall be removed before interconnections.

11.0 INTERPOLE CABLING

11.1 All cables to be used by contractor shall be armoured and shall be as per IS - 1554 (1100 Volts Grade). All cables within & between circuit breaker poles shall be supplied by the CB manufacturer.

11.2 Only stranded conductor shall be used. Minimum size of the conductor shall be 2.5 sq.mm. (Copper).

11.3 The cables shall be with oxygen index Min-29 and temp. index as 250° C as per relevant standards.

12.0 FITTINGS AND ACCESSORIES

12.1 Following is a partial list of some of the major fittings and accessories to be furnished by Contractor in the Central Control cabinet. Number and exact location of these parts shall be indicated in the bid.

i) Cable glands (Double compression type), Lugs, Ferrules etc.

ii) Local/remote changeover switch.

iii) Operation counter

iv) Control switches to cut off control power supply.

v) Fuses as required.

vi) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for future use.

vii) Antipumping relay.

viii) Pole discrepancy relay.

ix) D.C. Supervision relays.

x) Rating and diagram plate in accordance with IEC incorporating year of manufacture.

13.0 ADDITIONAL DATA TO BE FURNISHED ALONGWITH THE OFFER:

a) Drawing, showing contacts in close, arc initiation, full arcing, arc extinction and open position.

b) The temperature v/s pressure curves for each setting of density monitor alongwith details of density monitor.

c) Method of checking the healthiness of voltage distribution devices (condensers) provided across the breaks at site.

d) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100% fault currents to load currents of the lowest possible value without requiring any maintenance or checks.

e) The effect of non-simultaneity between contacts between poles and also show how it is covered in the guaranteed total break time.

f) Sectional view of non-return couplings if used for SF6 pipes.

g) Details & type of filters used in interrupter assembly and also the operating experience with such filters.

h) Details of SF6 gas:

i) The test methods used in controlling the quality of gas used in the circuit breakers particularly purity and moisture content.

ii) Proposed tests to assess the conditions of the SF6 within a circuit breaker after a period of service particularly with regard to moisture contents of the gas.

i) A complete catalogue on operation analyser satisfying all the requirements of this Chapter.

j) The bidders shall furnish along with the bid, curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and pneumatic/hydraulic pressure.

k) Field test report or laboratory test report in case of CB meant for reactor switching duty.

14.0 TESTS:

14.1 In accordance with the requirements stipulated under specification the circuit breaker along with its operating mechanism shall conform to IEC:62271-100.

14.2 The test reports of the type tests and the following additional type tests shall also be submitted for Purchaser's review:

i) Corona extinction voltage test .

ii) Out of phase closing test as per IEC:62271-100.

iii) Line charging breaking current for proving parameters as per clause no. 17.9 of this Chapter.

iv) Test to demonstrate the Power Frequency withstand capability of breaker in open condition at Zero Gauge pressure and at lockout pressure.

v) Seismic withstand test in unpressurised condition.

vi) Verification of the degree of protection.

vii) Low & high temperature test.(if applicable)

viii) Humidity test.(if applicable)

ix) Static Terminal Load test.

x) Critical Currents test (if applicable).

xi) Switching of Shunt Reactors.

14.3 **Routine Tests**

Routine tests as per IEC:62271-100 shall be performed on all circuit breakers.

In addition to the mechanical and electrical tests specified by IEC, the following tests shall also be performed.

i) Speed curves for each breaker shall be obtained with the help of a suitable operation analyser to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic/hydraulic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyser alongwith necessary transducers, cables, console, etc. where included in scope of supply shall be furnished and utilised. In case of substations where operation analyser is existing the bidder shall utilise the same. However necessary adopter and transducers etc. if required shall have to be supplied by the bidder.

ii) Measurement of Dynamic Contact resistance measurement for arcing & main contacts. Signature of Dynamic contact resistance measurements shall be taken as reference for comparing the same during operation and maintenance in order to ascertain the healthiness of contacts.

14.4 **Site Tests:** All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site.

15.0 TECHNICAL PARTICULARS 145 kV CIRCUIT BREAKER

15.1	Rated continuous current (A) at design ambient temperature.	1250
15.2	Rated short circuit current breaking capacity at rated voltage	31.5 kA for/Sec with percentage DC component as per IEC: 62271-100 corresponding to minimum opening time under operating conditions specified
15.3	Symmetrical interrupting capability (kA rms)	31.5
15.4	Rated short circuit making current (kAp)	80

15.5	Short time current carrying capability for one second (kA rms)	31.5
15.6	Out of phase braking current capacity (kA rms)	As per IEC
15.6	Rated operating duty	O-0.3sec-CO-3min-CO cycle
15.7	Temperature rise over the	As per IEC
15.8	Three phase autoreclosing First pole to clear factor	As per IEC
15.9	Rated line/cable charging. Interrupting current at 90^0 leading power factor angle(A.rms) (The breaker shall be able to interrupt the rated line/cable charging current with test voltage immediately before opening equal to be product of $U/\sqrt{3}$ and 1.4 as per IEC: 62271-100)	
15.10	Design ambient temperature	

15.11	i) Total break time as per Cl.3.0 of this Chapter (ms)	As per IEC: 62271-100 65
	ii) Rated break time as per IEC (ms)	
	Total closing time (ms)	
	Operating mechanism or a combination of these	60
	Max. difference in the instants of closing/ opening of contacts (ms) between poles at rated control voltage and rated operating and quenching media pressures.	Not more than 150 spring
	Trip coil and closing coil voltage	3.3
	Noise level at base and upto 50 m (distance from base of breaker)	140 dB(Max)
	Rated terminal load	As per IEC or as per the value Calculated by Chapter GTR, whichever is higher

Auxiliary contacts	Besides requirement of specification, the bidder shall wire up 5 NO + 5 NC contacts for future use of Purchaser.
No. of Terminals in common control cabinet	All contacts & control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for Purchaser's use.
Maximum allowable switching overvoltage under any switching condition	As per IEC
Rated small inductive current switching capability with overvoltage less than 2.3 p.u.(A)	0.5 to 10

(Auxiliary switch shall also comply with requirements stipulated under specification).

16. TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Employer for approval.

(a) Insulation resistance of each pole.

(b) Check adjustments, if any suggested by manufacturer.

(c) Breaker closing and opening time.

(d) Slow and Power closing operation and opening.

(e) Trip free and anti pumping operation.

(f) Minimum pick-up voltage of coils.

(g) Dynamic Contact resistance measurement.

(h) Functional checking of compressed air plant and all accessories.

(i) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.

(j) Insulation resistance of control circuits, motor etc.

(k) Resistance of closing and tripping coils.

(l) SF6 gas leakage check.

(m) Dew Point Measurement

(n) Calibration of pressure switches and gas density monitor.

(q) Checking of mechanical ‘CLOSE’ interlock, wherever applicable

6. Specification for 132 KV Isolators

1.0 GENERAL:

1.1 The Isolators and accessories shall conform in general to IEC: 62271-102 (or IS: 9921) except to the extent explicitly modified in specification and shall be in accordance with requirement of specification.

1.2 Isolators shall be outdoor, off-load type. Earth switches shall be provided on Isolators wherever called for.

1.3 Complete isolator with all the necessary items for successful operation shall be supplied including but not limited to the following.

1.3.1 Isolator assembled with complete base frame, linkages, operating mechanism, control cabinet, interlocks etc.

1.3.2 All necessary parts to provide a complete and operable isolator installation, control parts and other devices whether specifically called for herein or not.

1.3.3 The isolator shall be designed for use in the geographic and meteorological conditions as given in specification.

2.0 DUTY REQUIREMENTS:

a) Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the systems in their closed position. They shall be constructed such that they do not open under influence of short circuit current.

b) The earth switches, wherever provided, shall be constructionally interlocked so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical and mechanical interlocks provided in the operating mechanism.

c) In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of fail safe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated in specification.

d) The earth switches shall be capable of discharging trapped charges of the associated lines.

e) The isolator shall be capable of making/breaking normal currents when no significant change in voltage occurs across the terminals of each pole of isolator on account of make/break operation.

f) The isolator shall be capable of making/breaking magnetising current of 0.7A at 0.15 power factor and capacitive current of 0.7A at 0.15 power factor at rated voltage.

3.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of Double Break Isolators, turn twist type earth switches and accessories shall be in accordance with requirements stated hereunder:

3.1 Contacts:

a) The contacts shall be self aligning and self cleaning and so designed that binding cannot occur after remaining closed for prolonged periods of time in a heavily polluted atmosphere.

b) No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the isolator or earth switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.

c) Contact springs shall not carry any current and shall not loose their characteristics due to heating effects.

3.2 Base :

Each single pole of the isolator shall be provided with a complete galvanised steel base provided with holes and designed for mounting on a supporting structure.

3.3 Blades :

a) **All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper/aluminium.** Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be

made of non-corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast-steel. No grey iron shall be used in the manufacture of any part of the isolator.

b) The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Corona shields/rings etc., shall be made up of aluminum/aluminum alloy.

c) Isolators and earth switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism.

d) The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals. i.e. after every 1000 operations or after 5 years whichever is earlier.

3.4 **Insulator :**

a) The insulator shall conform to IS: 2544 and/or IEC-168. The porcelain of the insulator shall conform to the requirements stipulated in specification and shall have a minimum cantilever strength of **600 Kg**. for 145 kV insulators.

b) Pressure due to the contact shall not be transferred to the insulators after the main blades are fully closed.

c) The parameters of the insulators shall meet the requirements specified in specification.

d) Insulator shall be type and routine tested as per IEC-168. Besides following additional tests shall also be conducted:

(i) Bending load test in four directions at 50% of minimum bending load guaranteed on all insulators, as a routine test.

(ii) Bending load test in four directions at 100% of minimum bending load as a sample test on each lot.

(iii) Torsional test on sample insulators of a lot.

(iv) Ultrasonic test as a routine test.

e) For 145 kV Insulator : (For Isolator)

Top PCD	=	127
No. of holes	=	4 x M16
Bottom PCD	=	**254** mm
No. of holes	=	8 x 18 dia

3.5 **Name Plate :**

The name plate shall conform to the requirements of IEC incorporating year of manufacture.

4.0 EARTH SWITCHES :

a) Where earth switches are specified these shall include the complete operating mechanism and auxiliary contacts.

b) The earth switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator.

c) Earth switches shall be only locally operated.

d) The earth switches shall be constructionally interlocked with the isolator so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks.Suitable mechanical arrangement shall be provided for de-linking electrical drive for mechanical operation.

e) Each earth switch shall be provided with flexible copper/aluminum braids for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earth blade. The transfer of fault current through swivel connection will not be accepted.

f) The plane of movement and final position of the earth blades shall be such that adequate electrical clearances are obtained from adjacent live parts in the course of its movement between ON and OFF position.

g) The frame of each isolator and earth switches shall be provided with two reliable earth terminals for connection to the earth mat.

h) Isolator design shall be such as to permit addition of earth switches at a future date. It should be possible to interchange position of earth switch to either side.

i) The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

j) The earth switches shall also comply with the requirements of IEC-1129, 1992 in respect of induced current switching duty as defined for Class-B earth switches.

5.0 OPERATING MECHANISM :

a) The bidder shall offer motor operated Isolators and earth switches.

b) Control cabinet/operating mechanism box shall conform to the requirement stipulated in specification and shall be made of aluminum sheet of adequate thickness (minimum 3 mm).

c) A "Local/Remote" selector switch and a set of open/ close push buttons shall be provided on the control cabinet of the isolator to permit its operation through local or remote push buttons.

d) Provision shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.

e) Motor shall be an AC motor and conform to the requirements of specification.

f) Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. The mechanism shall stop immediately when motor supply is switched off. If necessary a quick electromechanical brake shall be fitted on the higher speed shaft to effect rapid braking.

g) Manual operation facility (with handle) should be provided with necessary interlock to disconnect motor.

h) Gear should be of forged material suitably chosen to avoid bending/jamming on operation after a prolonged period of non operation. Also all gear and connected material should be so chosen/surface treated to avoid rusting.

i) The test report for blocked rotor test of motor shall be submitted as per the requirement of Technical Specification.

6.0 OPERATION :

a) The main Isolator and earth switches shall be individual gang operated in case of 145 kV. The operating mechanism of the three poles shall be well synchronized and interlocked.

b) The design shall be such as to provide maximum reliability under all

service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and inter pole operating rods shall be capable of adjustments, by means of screw thread which can be locked with a lock nut after an adjustment has been made. The isolator and earth switches shall be provided with "over center" device in the operating mechanism to prevent accidental opening by wind, vibration, short circuit forces or movement of the support structures.

c) Each isolator/pole of isolator and earths shall be provided with a manual operating handle enabling one man to open or close the isolator with ease in one movement while standing at ground level. The manual operating handle shall have provision for pad locking. The operating handle shall be located at a height of 1000 mm(approximately) from the base of isolator support structure.

d) The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator.Wherever supported the operating rods shall be provided with bearings on either ends. The operating rods/ pipes shall be provided with suitable universal couplings to account for any angular misalignment.

e) All rotating parts shall be provided with grease packed roller or ball bearings in sealed housings designed to prevent the ingress of moisture, dirt or other foreign matter. Bearings pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rustproof.

f) Signaling of closed position shall not take place unless it is certain that the movable contacts, have reached a position in which rated normal current, peak withstand current and short time withstand current can be carried safely. Signaling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is at least 80% of the isolating distance.

g) The position of movable contact system (main blades) of each of the Isolators and earth switches shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the Isolators and earth switch. The indicator shall be of metal and shall be visible from operating level.

h) The contractor shall furnish the following details along with quality norms, during detailed engineering stage.

(i) Current transfer arrangement from main blades of isolator along with milli volt drop immediately across transfer point.

(ii) Details to demonstrate smooth transfer of rotary motion from motor shaft to the insulator along with stoppers to prevent over travel.

7.0 TERMINAL CONNECTORS:

The terminal connector shall meet the requirements as given in specification.

8.0 SUPPORT STRUCTURE:

145 kV Isolators shall be suitable for mounting on support structures to be supplied in accordance with specification.

9.0 TESTS:

9.1 In continuation to the requirements stipulated under specification, the isolator along with its earth switch and operating mechanism should have been type tested as per IEC/IS and shall be subjected to routine tests in accordance with IEC-129/IEC-1129. Power frequency voltage withstand tests shall be performed on at least one completely assembled isolator pole of each type. Alternatively, power frequency test may be performed on two nos. of Post Insulators (complete) for each voltage rating and type of Isolator. Minimum 50 Nos. mechanical operations will be carried out on 1 (one) isolator out of every ten Isolators assembled completely with all accessories as acceptance test for the lot.

9.2 Site Tests:

All routine tests including 50 operation test, except power frequency dry voltage withstand test on isolator shall be repeated on completely assembled isolator of each type at site.

10.0 Deleted

11.0 TECHNICAL PARAMETERS:

145 kV ISOLATORS:

11.1	Type	Outdoor
11.2	Rated Current at 50deg. Ambient temperature	1250/1600 A as applicable And detailed under price schedule.

11.3	Rated short time withstand current of isolator and earth switch	31.5 kA for 1 Sec.
11.4	Rated dynamic short circuit withstand current of isolator and earth switch	80 kAp
11.5	Temperature rise over design ambient temperature	As per table V of IEC-694.
11.6	Rated mechanical terminal load.	As per table III of IEC-129(1984).
11.7	Operating mechanism of isolator/earth switch	A.C. Motor operated
11.8	No. of auxiliary contacts on each isolator	Besides requirement of this spec., 5 NO + 5 NC to contacts, wired to terminal block exclusively for Purchaser's use in future.
11.9	No. of auxiliary contacts on each earthing switch	Besides requirement of this spec., the bidder shall wire up 3 NO + 3 NC to TBs (Reversible) for Purchaser's future use.
11.10	Operating time	12 sec. or less
11.11	Number of terminal in control cabinet (Interpole cabling shall be supplied by Contractor)	All contacts & control circuits are to be wired upto control cabinet plus 24 spare terminals evenly distributed.

12.0 TESTING AND COMMISSIONING

12.1 An indicative list of tests on isolator and earthswitch is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance of each pole.

(b) Manual and electrical operation and interlocks.

(c) Insulation resistance of control circuits and motors.

(d) Ground connections.

Contact resistance.

(e) Proper alignment so as to minimise to the extreme possible the vibration during operation.

(f) Measurement of operating Torque for isolator and Earth switch.

(h) Resistance of operating and interlocks coils.

(i) Functional check of the control schematic and electrical & mechanical interlocks.

7. LIGHTING SYSTEM

1.1 The scope of work comprises of design, engineering, testing, supply, installation, testing and commissioning of various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, exhaust fans for toilets and pantry & accessories, lighting panels, lighting poles complete with distribution boxes, galvanised rigid steel conduits, lighting wires, G.I. Earthwire, receptacles, tag block & telephone socket, switchboards, switches, junction boxes, pull out boxes complete with accessories, lighting transformer.

1.2 **SYSTEM DESCRIPTION**

A lighting system shall comprise of the following :

1.2.1 **AC Normal Lighting**

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards.

1.2.2 **AC Emergency Lighting**

This system will be available in control room building, Fire fighting pump house ,DG Set building & switchyard. AC lighting load will be connected to this system which will be normally 'ON'. The lighting panels of this system will be connected to the Emergency lighting board which is fed from diesel generator during the emergency. 50% of lighting fixtures shall be connected on AC emergency lighting.

1.2.3 **D.C. Emergency lighting**

A few DC emergency lighting fixtures operated on the DC system will be provided in the strategic locations including staircase, corridors, electrical rooms, Battery charger room, LT switchgear room in control room building, Fire fighting pump house and DG Set building so that the operating personnel can safely find their way even during emergency of a total AC failure. These lights will be normally 'OFF' and will be switched 'ON' automatically when under voltage occurs in the AC main lighting distribution board. GLS lamp down lighters in false ceiling area and Bulkhead fixtures in non false ceiling area to be used.

1.2.4 **Portable Fixtures**

One numbers of battery operated, portable fixtures will be provided in the Control room building.

1.3 The lighting layout for and around Control Room Cum Administrative Office Building shall be furnished by tenderers

The lux levels to be maintained in the switchyard shall be as per following:

Sl.No	Area	Average Lux Level
i)	Switchyard	-50 lux on main Equipments(i.e, Transformer, Reactor ISO,CB,CT,CVT,SA) at first level (Equipment connections level.) -20 lux on balance area of switchyard and street / RoAD at ground level

The minimum lux level to average lux level ratio should not be less than 0.3 (i.e Emin/Eav>0.3). The maintenance factor for outdoor illumination design shall be considered as 0.65.

For achieving the specified lux levels in the switchyard, the contractor can provide luminaries of 1x400 W/1x250 W and 2x400 W/ 2x250 W flood light as per requirement.

The contractor shall submit detailed calculation for reaching the above Lux level. Contractor shall conform the Lux levels at different locations of the switch yard and street lighting by measurement.

In addition to the normal lighting provided in the switchyard area to maintain the desired lux levels, few high beam fixtures on swivel support shall be provided in strategic locations near equipments which shall be kept normally OFF and these shall be switched ON in case of maintenance work.

1.4 Ceiling fans (1400 mm sweep, AC 230 volts) shall be provided in the non A C rooms in the control room building.

1.5 One no. of aluminium ladder of each size shall be supplied by the contractor for maintenance purpose.

1.6 The following specific areas are included in the scope of lighting: (i) Switchyard Area. (ii) Switchyard Control Room cum Administrative Office Building (iii) Street lighting (peripherial) inside switchyard fencing be done using street lighting poles) (iv) Landscape Lighting around control room

1.7(a) **For Outdoor Illumination**

The switchyard and street lighting design, detailed drawings showing the lighting layout and Electrical distribution diagram shall be prepared by the Contractor and submitted for approval. The above layout drawings will include disposition and location of lighting fixtures, receptacles, etc.

1.7(b) **For Indoor Illumination**

The conduit layout for substation buildings based on the tender drawings, Electrical distribution diagram for substation buildings & for landscape lighting cable schedule for substation yard etc. shall be prepared by the Contractor. All wiring including telephone wiring (tinned two pair copper) shall be in concealed conduit. Concealed MS junction boxes for sockets and light points shall be provided in all the rooms of Control Room cum Administrative Office Building and DG Building cum Fire Fighting pump house.

1.8 Each cable and conduit run shall be tagged with number that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance and/or exit from any piece of equipment, junction or pull box, floor opening etc.

1.9 The tag shall be made up of aluminium with the number punched on it and securely attached to the cable by not less than two turns of G.I. wire. Cable tags shall be rectangular in shape for power cables and circular shape for control cables.
supply

1.10 Location of cables laid directly under ground shall be indicated clearly by cable marker made of galvanised iron plate embedded in concrete block.

1.11 The location of under ground cable joints if any, shall be clearly indicated with cable marker with an additional inscription "cable joint".

1.12 The marker, which is a concrete block, shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction. It shall also be located on both sides of the road or drain crossing.

2. DESCRIPTION OF ITEMS

The Contractor shall and install the following equipment and accessories in accordance with the specification.

2.1 LIGHTING PANELS

2.1.1 OUTDOOR

415 AC lighting panel with 415V, 63A, 3 phase 4 wire bus and one no. 63A, TPN, MCB with neutral unit as incomer and 20A, MCB as outgoing feeders, the details are as follows:

Type Description Details of outgoing feeders) ACP-2 Outdoor 6 nos.-20 A single pole MCB and3 No. 32 A Tripple pole MCB with Neutral and suitable timer and contactor for automatic switching.

ACP-3 Outdoor street lighting 3 nos. 32A Tripple pole MCB panel with Neutral with suitable timer and contactor for automatic switching

Note: The number of outgoing feeders indicated above are the minimum.

2.1.2 INDOOR

415 V indoor AC lighting panel ,63 A 3 phase 4 wire bus and one number 63 amp TPN MCB with 300ma 63 A RCCB. Flush mounted with per phase isolation and indication lamps din mounted . The DB will be flush mounted.

ACP-1 Indoor 18 nos outgoing 16-32 Amps SPMCP

2.2 220V DC indoor type change over board and 220V DC 32A two wire bus and one 32A contractor backed up by 32A double pole MCB as incomer. The panel shall have local push button controls. Following are the various types of panels required with control timer.

Type Description Details of outgoing feeders) DCP Indoor 6 nos.-16A DP MCB unit

2.3 **Sub-Lighting Panels**

---------- Type Description ----------
------- SLP 4 pole 32A Isolator suitable for 415V, 50 cycles AC supply, with LILO facility using 8 nos terminal
blocks suitable for cable upto 16 mm sq cable
Enclosure shall be suitable for outdoor use with IP-55 degree of protection as per IS:13947 (Part-1).

2.4 Lighting Fixtures and Receptacles

Lighting Fixtures

Type Description

SC 150W SON-T Tubular Sodium Vapour lamp in street lighting luminare. A special optical reflector clear acrylic cover, a single piece die cast aluminium housing made out of LM6 and corrosion resistance proof. Similar to Philips Cat No. SRX- 51 and Bajaj Cat No. BJMSDT/150 / Crompton Greaves Cat No. SSG 23151H .(Street Light Luminaire should be suitable for Bottom Entry/Side entry both for pipe mounting)

FI 2x36W flourescent lamps in industrial reflector type fixture, complete with accessories and suitable for pendent Mounting, similar to Philips Cat. No. TKC 24/236/Bajaj Cat. No. : BJIV-236 /Crompton Greaves Cat No. 1VE 1224 HSB

IF Incandescent GLS lamp in recessed down light having high purity aluminium reflector electrochemically brightened and anodized.
Stainless steel leaf springs and pressure die cast 1ceiling similar to Philips Cat.No. DN-622 Crompton greaves cat DDLV 10-BC

SFI Wheather proof integral Floor Lighting with housing made of corrosion resistant die cast aluminium painted black. Grey powder coated outside suitable for 150W SON-T lamp complete with all accessories and suitable for termination with conduits/flexible Cat. No. F69045 (C).Similar to Philips Cat. No. SWF230/150/BajajCat.No.BGEMF-150WSV Crompton Greaves Cat No. FAD 11151H

SF2 2 x 400 / 2x250W HP Sodium vapour lamps in high Flood lighting fixture suitable for outdoor mounting with aluminium enclosure : similar to PhilipsCat.No. SNT001/Bajaj Cat.No. BJEF-22CA /Crompton Greaves Cat No. FHD1324

SF3 1 x 250 / 1 x 400 HP sodium vapour lamps in high Technical Specification,

flood lighting fixture suitable for outdoor mounting with aluminium enclosure and integral control gear: similar to Phillips cat. No. SWF 330/ CGL Cat. No. FAD 1114/ Bajaj Cat. No. BJEF T14CA.

PF 1x11 W CFL Lamp emergency light with Battery operated portable fixture with built in chargable Batteries and battery charger suitable for a lighting period of six hours similar to ALPHA DELUX of M/s DELTA FLASH LITE/MICRO LITE OF M/s MICRO /BPL MAKE

FB 9W CFL lamp in Bulkhead fixtures with Cast Aluminium alloy body, suitable for column, wall,and ceiling mounting finished stove enameled silver grey outside white inside, to be supplied complete (with front cover, wire guard, tropicalised, gasket and lamp holder taped 3/4" E.T. for conduit entry) similar to Philips Cat.No.FXC 101/Bajaj Cat.No. BJBE-19/Crompton Greaves.

FF 2x36W flourescent lamp with mirror optics in recessed mounting type decorative flourescent fitting consisting of white stove enamelled sheet steel housing with accessories and reflector of aluminium sheet steel duty electro-chemically brightened and anodised fitted with aluminium lamellae painted white.Similar to Philips Cat.No. TBS-285/236 and Bajaj Cat.No. BJLM-236/ Crompton Greaves Cat. No. CRFA 24 HSB

FL 2x36W flourescent lamps in decorative lighting fixture with widespread mirror optics suitable for pendent mounting with twin tube complete with all accessories : similar to philips cat-No. TCS-306/236 and Bajaj Cat.No. BJSM-236/Crompton Greaves Cat No.CSB W 1124 HSB

Cat No. MPT12IH/BC IB 60/100w GLS lamp in Bulkhead fixtures with Cast Aluminium alloy body, suitable for column, wall,and ceiling mounting finished stove enameled silver grey outside white inside, to be supplied complete (with front glass, wire guard, tropicalised, gasket and E.S. Porcelain, lamp holder taped 3/4" E.T. for conduit entry) similar to Philips Cat.No.NXC 101/ /Crompton Greaves IBH1110/BC

BL 2X9 Or 1x18 watt CFL bollard light for landscape lighting having FRP/LLDPE housing similar to Philips FGC202 /Crompton Greaves Cat No CFBL1129

DLR 2x18 watt CFL Down light for recess mounting lighting having similar to Philips FBH225/2X18 /Crompton Greaves Cat No DDLH218TG

DSM 1X13 WATT surface mounted CFL similar to Art Light Make Cat NO RL 3146

HL 2X 18 CFL Decorative hanging down Light Simiilar to cat no Art light RL 3166/HL

CL 1X 18 WATT Decorative celling mounted luminaire similar to Philips Dixie Cat FL 343/118

2.5 **RECEPTACLES**

RO 15A, 240V, Outdoor Receptacle 2 pole, 3- pin type R1 5/15A, 240V, Indoor Receptacle 3-pin type. RP 63A, 415V, Interlocked switch socket, outdoor receptacle

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2.6 SWITCH BOARDS
Modular type switches, 5/15 Amp. Receptacles.

2.7 CONDUITS AND ACCESSORIES
Galvanised Rigid Steel Conduits of 19mm/25mm/32mm/40mm dia.

2.8 JUNCTION BOXES with 5 Nos.of terminal blocks

2.9 LIGHTING POLES - (Type A1 poles & Type E1 poles)

2.10 CEILING FANS-1400 mm Sweep with Electronic regulator

2.11 MAINTENANCE EQUIPMENT
i) A type Aluminium ladder of 3 mtr vertical height. ii) Cartwheel mounted aluminium ladder Vertical Height 7.5 Mtrs. When Extended

3. LIGHTING FIXTURES AND ACCESSORIES

3.1 General
All lighting fixtures and accessories shall be designed for continuous operation under atmospheric conditions existing at site, without reduction in the life or without any deterioration of materials, internal wiring.

3.2 Temperature Rise
All lighting fixtures and accessories shall be designed to have a low temperature rise according to the relevant Indian Standards. The design ambient temperature shall be taken as 50 deg.C.

3 .3 Supply Voltage

3.3.1 Lighting fixtures and accessories meant for 240V A.C. operation shall be suitable for operation on 240V A.C. 50Hz, supply voltage variation of ± 10%, frequency variation of ± 5% and combined voltage and frequency variation of ± 10%. Technical

3.3.2 Lighting fixture and accessories meant for 220V DC operation shall be suitable for operation on 220V DC with variation between 190 to 240 Volts.

3.4 Lighting Fixtures

The lighting fixtures shall be philips or Bajaj or Crompton Greaves make only except for fixtures type 'DSM' & 'HL' for which make has been specified elsewhere in this section. The different types of lighting fixtures are also indicated elsewhere in this Section.

3.4.1 All fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.

3.4.2 All lighting fixtures shall be complete with fluorescent tubes / incandesent lamps/mercury vapour/sodium vapour lamps as specified and shall be suitably wired up.

3.4.3 All flourescent lamp fixture shall be complete with all accessories like ballasts, power factor improvement capacitors, lamps, starters, holders etc.

3 4.4. High beam fixtures shall be suitable for pendant mounting and flood lights shall have suitable base plate / frame for mounting on steel structural member. Hook mounted high beam fixtures are not acceptable.

3.4.5 Each lighting fixture shall be provided with an earthing terminal suitable for connection to 16 SWG GI earthing conductors.

3 .4 6. All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified by the manufacturer.

3.4.7 Height of fixtures should be such that it is easy to replace the lamps with normal ladder/stool. In case the ceiling height is very high, the fixtures may be placed on the walls for ground lighting.

3.5 **ACCESSORIES**

3.5.1 Reflectors

The reflectors shall be manufactured from sheet steel or aluminium as applicable. They shall be securely fixed to the captive type.

3.5.2 Lamp holders and Starter Holders

(a) Lamp holders/starter holders for fluorescent tubes shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or retention of the lamp/starter. They shall hold the lamp/starter in position under normal condition of shock and vibration.

(b) Lamp holders/starter for incandescent lamps and HPMV/HPSV lamps shall be of screwed type, manufactured in accordance with relevant standard and designed to give long and satisfactory service.

3.5.3 Ballasts

a) The Ballasts shall be designed, manufactured and supplied in accordance with relevant standard and function satisfactorily under site condition specified. The ballasts shall be designed to have a long service life and low power loss.

b) Ballasts shall be mounted using self locking anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.

c) The ballasts shall be of the inductive, heavy duty type, filled with thermosetting insulating moisture repellent polyester compound filled under pressure or vacuum. The ballast wiring shall be of copper wire. They shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Contractor. Ballasts for high pressure mercury vapour/ HPSV lamps shall be provided with suitable tappings to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure.

d) Separate ballast for each lamp shall be provided in case of multi-lamp fixtures.

3.5.4 Starters

Starters shall have bimetal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference suppressing capacitor.

3.5.5 Capacitors

a) The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

b) The capacitors shall be suitable for operation at supply voltage as specified and shall have a value of capacitance so as to correct the power factors of its corresponding lamp circuit to the extent of 0.98 lag.

c) The capacitors shall be hermetically sealed in a metal enclosure.

3.6 Lamps

3.6.1 General Lighting Services (GLS) lamps shall be provided with screwed caps and shall be of 'clear' type unless otherwise specified.

3.6.2 The flourescent lamps shall be 'Day-light-colour' type unless otherwise specified and shall also be provided with features to avoid blackening of lamps ends. The Bidder should clearly state these features in the bid.

3.6.3 Mercury vapour lamps, sodium vapour lamps shall be colour corrected type, with screwed caps.

3.7 The Bidder shall furnish typical wiring diagram for Fluorescent, HPMV & HPSV fitting including all accessories. The diagram shall include technical details of accessories i.e. starters, chokes, capacitors etc.

3.8 Flexible conduits if required, for any fixture shall be deemed to be included in Contractor's scope.

4. RECEPTACLES

a) All receptacles shall be of cast steel/aluminium, heavy duty type, suitable for fixing on wall/column and complete with individual switch.

b) In general the receptacles to be installed are of the following types :

i) Type RO-15A, 240V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having cable gland entry suitable for 2Cx6 sq.mm. PVC/aluminium armoured cable and a metallic cover tied to it with a metallic chain and suitable for installation in moist location and or outdoor. The switch shall be of rotary type. Receptacles shall be housed in an enclosure made out of 2 mm thick Gl sheet with hinged doors with padlocking arrangements. Door shall be lined with good quality gasketing. This shall conform to IP-55.

ii) Type RI The 5/15 amp 6 pin receptacles with switches will be of Modular type with flush type switches and electroplated metal enclosures of approved make

iii) Type RP - 63A, 415V, 3 phase, 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as type RO. The receptacle shall be suitable for 3.5C x 35/3.5Cx70 sq.mm. aluminium conductor cable entry and shall also be suitable for loop-in and loop out connection of cables of identical size. Receptacle shall be suitable for outdoor application. Receptacles shall be housed in a box made out of 2mm thick G.I. sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gasketing. This shall conform to IP-55.

5. SWITCH AND SWITCHBOARD

(a) All Switch board/boxes, 5/15 Amp Receptacles and electronic fan regulators located in office/building areas shall be modular flush mounted type or brick wall with only the switch knob projecting outside.

(b) Switch boards/boxes shall have conduit knock outs on all the sides. Adequate provision shall be made for ventilation of these boxes.

(c) The exact number of switches including regulator for fans and layout of the same in the switchboard shall be to suit the requirement during installation.

(d) The maximum number of luminaires ,controlled by one no 6 amp switch would be 4 nos. For DC fixtures there will be no switch and the same shall be directly controlled from DC LP

(e) The luminaires shall be wired in such a fashion that luminaires on each phase are evenly distributed all over the room.

6. CONDUITS & CONDUIT ACCESSORIES

6.1 The conduits shall conform to IS:9537. All conduits shall be seemed by welding, shall be of heavy gauge and shall be hot dip galvanised.

6.2 Flexible conduits wherever required shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips.

6.3 All conduits accessories shall conform to relevant IS and shall be hot dip galvanised.

7. JUNCTION BOXES

7.1 The junction boxes shall be concealed type for indoor lighting and suitable for mounting on columns, lighting poles, structures etc., for outdoor lighting.

7.2 Junction boxes shall be of square/rectangular type of 1.6 mm sheet steel with minimum 6 mm thick pressure diecast aluminium material LM-6 and shall have bolted cover with good quality gasket lining.

7.3 The junction box and cover shall be hot dip galvanised.

7.4. The junction boxes shall be complete with conduit knockouts/threaded nuts and provided with terminal strips .The junction boxes shall be suitable for termination of conduit/glands of dia 20 mm, 25 mm, 32 mm, 40 mm on all sides. The junction boxes

shall be provided with 4 way terminals suitable for two numbers 10 sq. mm. wire & for street lighting/switchyard lighting suitable for 2 numbers 4C x 16 Sq.mm Al. cable.

7.5 The junction boxes shall have the following indelible markings
(i) Circuit Nos. on the top.
(ii) Circuit Nos. with ferrules (inside) as per drawings. (iii) DANGER sign in case of 415 volt junction box.

7.6 The junction boxes shall be weather proof type with gaskets conforming to IP 55 as per IS:13947 (Part I) . The conduit connections shall also be properly sealed to prevent entry of water.

8. TERMINAL BLOCKS

8.1 Each terminal shall be suitable for terminating upto 2 Nos. 10 sq.mm. stranded Aluminium Conductors without any damage to the conductors or any looseness of connections. Terminal strips provided in street - lighting poles shall be suitable for terminating upto 2 nos. 4C x 16 sq. mm aluminium cables.

9. PULL OUT BOXES

9.1. The pull out boxes shall be concealed type for indoor lighting and suitable for mounting on column, structures etc., for outdoor lighting. The supply of bolts, nuts and screws required for the erection shall be included in the installation rates.

9.2 The pull out boxes shall be circular of cast iron or 16 SWG sheet steel and shall have cover with good quality gasket lining.

9.3 The pull out boxes and cover shall be hot dip galvanised.

9.4 The pull out boxes shall be completed with conduit knock outs/threaded hubs and provided at approximately 3 meters intervals in a conduit run.

10. LIGHTING PANELS (L.P.)

10.1 Each panel shall be provided with one incoming triple pole MCB with neutral link and outgoing miniature circuit breakers as per clause 2.0. The panels shall conform to IS-8623.

10.2 Constructional Features

10.2.1 Panels shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be of thickness not less than 2.00 mm (cold rolled) or 2.5 mm (hot rolled) smoothly finished, levelled and free from flaws. Stiffners shall be provided wherever necessary.The indoor lighting panels will be ready made DB of minimum 20 swg sheet thickness .

10.2.2 The panels shall be of single front construction, front hinged and front connected, suitable for either floor mounting on channels, sills or on walls/columns by suitable M.S. brackets.

10.2.3 Panels shall have a dead front assembly provided with hinged door(s) and out door panels will be with padlocking arrangement with single key supplied in duplicate.

10.2.4 All out door panels , removable covers, doors and plates shall be gasket all around with neoprene gaskets.

10.2 5 The panels shall be suitable for cable/conduit entry from the top and bottom. Suitable removable cable gland-plate shall be provided on the top and bottom of panels. Necessary number of double compression cable gland shall be supplied, fitted on to this gland plate. The glands shall be screwed on top and made of tinned brass.

10.2.6 The panels shall be so constructed as to permit free access to connection of terminals and easy replacement of parts.

10.2.7 Each panel shall have a caution notice fixed on it.

10.2.8 Each panel will be provided with directory holder in which printed and laminated as built circuit directory would be kept

10.2.9 Each Outdoor lighting panel shall be provided with one no. 'ON' indicating lamp for each phase alongwith fuses.For indoor lighting panels din mounted phase indication lamps will be provided , mounted along side of the MCB

10.3 Main Bus Bars

10.3.1 Bus bars shall be of aluminium alloy conforming to IS:5082 and shall have adequate cross-section to carry the rated continuous and withstand short circuit currents. Maximum operating temperature of the bus bars shall not exceed 85 deg. C. The bus bars shall be able to withstand a fault level of 9 kA for 1 sec. for AC panels and 4 KA for 1 sec. for DC panels.The Indoor lighting panels shall have copper bus bar

10.4 Residual Current Circuit Breakerss (RCCB)

10.4.1 For indoor panels 63A 4pole 300 ma conforming IS 12640 will be provided along with incomer

10.5 Miniature Circuit Breaker (MCB)

a) The miniature circuit breakers shall be suitable for manual closing, opening, automatic tripping under overload and short circuit. The MCBs shall also be trip free.

b) Single pole as well as three pole versions shall be furnished as required in the Schedule of Lighting Panels.

c) The MCBs and panel MCCB together shall be rated for full fault level. In case the MCB rating is less than the specified fault level the bidder shall co-ordinate these breaker characteristics with the back up MCCB in such a way that if fault current is higher than

breaker rating, the MCCB should blow earlier than the breaker. If the fault current is less than MCB breaking capacity, MCB shall operate first and not the incomer MCCB.

d) The MCBs shall be suitable for housing in the lighting panels and shall be suitable for connection with stranded copper wire connection at both the incoming and outgoing side by copper lugs or for bus bar connection on the incoming side.

e) The terminals of the MCBs and the 'open' 'close' and 'trip' conditions shall be clearly and indelibly marked.

f) The tenderer shall check and co-ordinate the ratings of MCBs with respect to starting characteristics of discharge lamps. The vendor has to furnish overload and short circuit curve of MCB as well as starting characteristics curves of lamps for Employer's approval.

g) The MCB shall generally conform to IS:8828.

10.6 Contactors

Contactors shall be of the full voltage, direct-on line air break, single throw, electro-magnetic type. They shall be provided with atleast 2-'NC' and 2'NO' auxiliary contacts. Contactor shall be provided with the three element, positive acting, ambient temperature compensated time lagged, hand reset type thermal overload relay with adjustable settings to suit the rated current. Hand reset button shall be flush with the front of the cabinet and suitable for resetting with starter compartment door closed. The Contactor shall be suitable for switching on Tungsten filament lamp also. The bidder shall check the adequacy of the Contactors rating wire with respect to lighting load.

10.7 Push Buttons

All push buttons shall be of push to actuate type having 2 'NO' and 2 'NC' self reset contacts. They shall be provided with integral escutcheon plates engraved with their functions. Push buttons shall be of reputed make.

10.8 Labels

a) The lighting panels shall be provided on the front with panel designation labels on a 3 mm thick plastic plate of approved type. The letter shall be black engraved on white back ground.

b) All incoming and outgoing circuits shall be provided with labels. Labels shall be made of non-rusting metal or 3 ply lamicold. Labels shall have white letters on black or dark blue background.

10.9 Earthing Terminals

Panels shall be provided with two separate and distinct earthing terminals suitable to receive the earthing conductors of size 50x6 G.S. Flat.

10.10 Type test reports for following tests on all lighting panels shall be submitted for approval as per clause 9.2 of section : GTR.

(i) Wiring continuity test

(ii) High voltage (2.5 KV for 1 minute) and insulation test (iii) Operational test

(iv) Degree of protection (not less than IP-55 test on outdoor Lighting Panels and IP-52 test on indoor Lighting Panels as per IS 13947 (part I)) (v) Heat run test

10.11 Lighting Transformer

Lighting transformer shall be located in MCC room, in seperate enclosure. Enclosure shall have degree of protection not less than IP-42 as per IS-13947 (Part-I).

11. Emergency Portable Lighting Fixtures

11.1 The portable fixtures shall have a built in battery rated for six hours, battery chargers and solid state inverters. These shall be of approved make.

11.2 The portable fixtures shall be of a single unit, completely tropicalised and suitable for prolonged use with no maintenance.

11.3 The portable fixtures shall be supplied and necessary supporting brackets of galvanised steel suitable for wall/column mounting shall also be supplied.

11.4 The portable fixture shall come up automatically in the event of failure of normal supply.

12. LIGHTING POLES

12.1 The Contractor shall supply, store and install the following types of steel tubular lighting poles required for street lighting.

a) Type A1 Street Lighting Pole - for one fixture
b) Type E1 Post top lantern pole - for one fixture

12.2 Street/flood light poles shall conform to the enclosed drawings. In front of control room building , DG Set and Fire Fighting Buildings, decorative post top lantern (Type E1) poles and Bollards shall be installed as per the quantities given in the tender drawing.

12.3 Lighting poles shall be complete with fixing brackets and junction boxes. Junction boxes should be mounted one meter above ground level.

12.4 The lighting poles shall be coated with bituminous preservating paint on the inside as well as on the embedded outside surface. Exposed outside surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium).

12.5 The galvanised sheet steel junction box for the street lighting poles shall be completely weather proof conforming to IP-55 and provided with a lockable door and HRC fuse mounted on a fuse carrier and fuse base assembly. The fuses & junction box shall be as specified in the specification. However, terminals shall be stud type and suitable for 2 nos. 16 sq.mm. cable.

12.6 Wiring from junction box at the bottom of the pole to the fixture at the top of the pole shall be done through 2.5 sq. mm wire.

12.7 Distance of centre of pole from street edge should be approximately 1000 to 1200 mm.

12.8 Earthing of the poles should be connected to the switchyard main earth mat wherever it is available and the same should be earthed through 3M long, 20 mm dia, earth electrode.

13. CEILING & WALL MOUNTED FANS AND REGULATORS

13.1 The contractor shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and switch, suspension rod, canopy and accessories.The wall mounted fans shall be of 400 mm sweep

13.2 The contractor shall supply and install the switch, electronic regulator and board for mounting switch and electronic regulator for celling fans.

13.3 Winding of the fans and regulators shall be insulated with Class-E insulating material. Winding shall be of copper wire.

13.4Electronic regulator with smooth control shall be provided.

13.5 Fans and electronic regulators shall be of Alstom / Crompton Greaves / Bajaj Electricals / Usha Electricals make.

14. LIGHTING WIRES

14.1 The wiring used for lighting shall be standard products of reputed manufacturers.

14.2 The wires shall be of 1100 V grade, PVC insulated product of reputed manufacturers.

14.3 The conductor sizes for wires used for point wiring beyond lighting panels shall be single core 4 sq. mm., 6 sq.mm and 10 sq.mm stranded aluminium wires and 2.5 sq.mm, 4 sq.mm, 6 sq.mm and 1.5 sq.mm stranded copper wire.

14.4 The wires used for connection of a lighting fixture from a nearest junction box or for loop-in loop-out connection between two fluorescent fixtures shall be single core copper stranded conductor, 1100V grade flexible PVC insulated cords, unsheathed, conforming to IS:694 with nominal conductor cross sectional areas of 2.5 sq. mm.

14.5 The wires shall be colour coded as follows:
Red for R - Phase
Yellow for Y - Phase
Blue for B - Phase
Black for Neutral
White for DC (Positive)
Grey for DC (Negative)

15. PAINTING OF SHOP MADE ITEMS

15.1 All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with IS:6005 'Code of Practice for Phosphating Iron and Steel'.

15.2 Oil grease and dirt shall be thoroughly removed by emulsion cleaning.

15.3 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying. 15.4 After phosphating through rinsing shall be carried out with clean water, followed by final rinsing with diluted dichromate solution and oven drying.

15.5 The phosphate coating shall be sealed by the application of two coats of ready mixed stoving type metal primer (comprising of red oxide and Zinc chromate in a synthetic medium). The first coat may be 'flash dried' while the second coat shall be stoved.

15.6 After application of the primer, two coats of finishing synthetic enamel paint shall be applied with each coat followed by stoving. The second finishing coat for the external of panels shall be applied after completion of tests.The panels can also be powder coated instead of painting after surface treatment as given above.

15.7 Both outside and inside of lighting panel, sheet metal fabricated junction boxes etc. and outside of lighting fixtures shall be finished in light grey (IS-5 shade 631). Inside of lighting fixtures shall be finished in white. The colour of indoor lighting panels should match with colour of wall.

15.8 Each coat of primer and finishing paint shall be of slightly different shade so as to enable inspection of the painting.

15.9 The final finished thickness of paint film on steel shall not be less than 100 microns and shall not be more than 150 microns.The final thickness of powder coating will not be less than 50 microns. For indoor lighting panels the painting will be as per approved manufacturers specification.

15.10 Finished painted appearance on equipment shall present on aesthetically pleasing appearance, free from dents and uneven surfaces.

16. LIGHTING SYSTEM INSTALLATION WORKS

16.1 General

16.1.1 In accordance with the specified installation instructions as shown on manufacturer's drawings or as directed by Employer, Contractor shall unload, erect, install, test and put into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workmanship manner so that it is level, plumb square and properly aligned and oriented. Tolerances shall be as established in manufacturers drawing or as stipulated by Purchaser.

16.1.2 All apparatus, connections and cabling shall be designed so as to minimise risk of fire or any damage which will be caused in the event of fire.

16.2 Conduit System

16.2.1 Contractor shall supply, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes (as specified in specification ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanised steel), caps,

square headed make plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes, glands, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits.The contractor shall also supply 19 mm PVC conduit and accessories for telephone wiring.

16.2.2 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles. etc.

16.2.3 Size of conduit shall be suitably selected by the Contractor.

16.2.4 Conduit support shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

16.2.5 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonary or concrete for conduit support is not acceptable.

16.2.6 Where conduits are alongwith cable trays they shall be clamped to supporting steel at an interval of 600 mm.

16.2.7 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

16.2.8 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

16.2.9 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

16.2.10 Conduits joints and connections shall be made through water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.

16.2.11 The entire metallic conduit system, shall be embedded, electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

16.2.12 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduit ends shall be plugged or capped to prevent entry of foreign material.

16.3 Wiring

16.3.1 Wiring shall be generally carried out by PVC insulated wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawings of wires is permissible.

16.3.2 Wires shall not be pulled through more than two equivalent 90 deg. bends in a single conduit run. Where required, suitable junction boxes shall be used.

16.3.3 Wiring shall be spliced only at junction boxes with approved type terminal strip.

16.3.4 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

16.3.5 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/junction box.

16.3.6 Maximum two wires can be terminated to each way of terminal connections.
16.3.7 Separate neutral wires are to be provided for each circuit.
16.3.8 AC and DC wiring should not run through the same conduit.

16.4 Lighting Panels
16.4.1 The lighting panels shall be erected at the locations to be finalised during detailed engineering.

16.4.2 Suitable foundations/supporting structures for all outdoor type lighting panels shall be provided by the Contractor.

16.5 Foundation & civil works
16.5.1 Foundation for street lighting poles, panel foundation and transformer foundation shall be done by the Contractor..

16.5.2 All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sills, inserts and flastening devices shall be carried out by the Contractor including minor modification of civil works as may be required for erection.

8 SWITCHYARD ERECTION

1.0 GENERAL

The detailed scope of work includes design, engineering, manufacture, testing at works, supply on FOR destination site basis, insurance, handling, storage, erection testing and commissioning of various items and works as detailed herein.

This section covers the description of the following items.

A- Supply of

- String insulators and hardware
- Galvanised Steel Earthwire
- Bus post insulators
- Earthing & Earthing materials

- Lightning protection materials
- Cabling material
- Other items

B. Erection Of all items

1.1 **String Insulators & Hardware**

The insulators for suspension and tension strings shall conform to IEC60383 and long rod insulators shall conform to IEC-60433. Insulator hardware shall conform to IS:2486.

Construction Features:

1.1.1 Suspension and tension insulators shall be wet process porcelain with ball and socket connection.Insulators shall be interchangeable and shall be

suitable for forming either suspension or tension strings. Each insulator shall have rated strength markings on porcelain printed and applied before firing.

1.1.2 Porcelain used in insulator manufacture shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

1.1.3 Glazing of the porcelain shall be uniform brown colour, free from blisters, burrs and other similar defects.

1.1.4 When operating at normal rated voltage there shall be no electric discharge between conductor and insulator which would cause corrosion or injury to conductors or insulators by the formation of substances due to chemical action. No radio interference shall be caused when operating at normal rated voltage.

1.1.5 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc used for galvanizing shall be of grade Zn-99.95 as per IS-209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains bulky white deposits and blisters.

1.1.6 Bidder shall make available data on all the essential features of design including the method of assembly of discs and metal parts, number of discs per insulator string insulators, the manner in which mechanical stresses are transmitted through discs to adjacent parts, provision for meeting expansion stresses, results of corona

and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

1.1.7 Clamps for insulator strings and Corona Control rings shall be of aluminium alloy as stipulated for clamps and connectors.

1.1.8 Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

1.1.9 The tension Insulator hardware assembly shall be designed for 11500 kg tensile load. Earth wire tension clamp shall be designed for 1000 kg tensile load with a factor of safety of two (2).

1.1.10 The tension string assemblies shall be supplied along with suitable turn buckle. Sag compensation springs if required may also be provided.

1.1.11 All hardware shall be bolted type.

1.2 **Long Rod Insulators**

1.2.1 As an alternative to disc insulator , Bidder can offer long rod insulators strings, with suitable hardware. The combination should be suitable for application specified and should offer the identical / equivalent parameters as would be available from insulator string comprising disc insulators and hardware combination.

1.2.2 All constructional features specified at Clause 1.1.1 of this Section shall also apply to the long rod insulator string.

1.3 **Tests**

In accordance with the stipulations of the specification, the suspension and tension strings, insulator and hardware shall be subjected to the following type tests, acceptance tests and routine tests:

1.3.1 **Type Tests on Insulator Strings :** The test reports for following type tests shall be submitted for approval :

a) Power frequency voltage withstand test with corona control rings under wet condition as per IEC 60383.

b) Switching surge voltage withstand test [400 kV class only] under wet condition

as per IEC-60383.

c) Lightning Impulse voltage withstand test with corona control rings under dry condition as per IEC-60383

d) Voltage distribution test (Dry)

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed 9% and 10% for 400KV suspension string and tension insulator string respectively, 13% for 220KV suspension and tension insulator strings, 20% and 22% for 132KV suspension and tension insulator strings respectively.

e) Corona Extinction Voltage test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320kV(rms) for 400kV and 156kV(rms) for 220kV line to ground under dry condition. There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

f) RIV Test (Dry)

Under the conditions as specified under (e) above the insulator string alongwith complete hardware fittings shall have a radio interference voltage level below 1000 microvolts at 1 MHz when subjected to 50 Hz AC line to ground voltage of 320kV for 400kV and 156kV for 220kV string under dry conditions. The test procedure shall be in accordance with IS 8263/IEC 60437.

g) Mechanical strength test

The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture

should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.3.2 **Type Tests on Insulators**

Type test report for Thermal Mechanical Performance tests as per IEC:60575, Clause 3 shall be submitted for approval as per clause specification.

1.3.3 **Acceptance Tests for Insulators:**

a) Visual examination as per IEC 60383

b) Verification of Dimensions as per IEC 60383.

c) Temperature cycle test as per IEC 60383.

d) Puncture Test as per IEC 60383.

e) Galvanizing Test as per IEC 60383.

f) Mechanical performance test as per IEC-60575 Cl. 4.

g) Test on locking device for ball and socket coupling as per IEC-60372(2)

h) Porosity test as per IEC 60383.

1.3.4 **Acceptance Test on Hardware Fitting**

a) Visual Examination as per Cl. 5.10 of IS:2486 (Part-I).

b) Verification of Dimensions as per Cl. 5.8 of IS : 2486 (Part-I)

c) Galvanising/Electroplating tests as per Cl. 5.9 of IS : 2486 (Part-I).

d) Slip strength test as per Cl 5.4 of IS-2486 (part-I)

e) Shore hardness test for the Elastometer (if applicable as per the value guaranteed by the Bidder).

f) Mechanical strength test for each component (including corona control rings and

arcing horns).

The load shall be so applied that the component is stressed in the same way as it would be in actual service and the procedure as given in 1.2.13.1 (g) above should be followed.

g) Test on locking devices for ball and socket coupling as per IEC:60372(2)

1.3.5 **Routine Test on Insulator**

a) Visual Inspection as per IEC60383

b) Mechanical Routine Test as per IEC60383

c) Electrical Routine Test as per IEC60383

1.3.6 **Routine Test on hardware Fittings**

a) Visual examination as per Cl 5.10 of IS : 2486 (Part-I).

b) Mechanical strength Test as per Cl. 5.11 of IS : 2486 (Part-I).

1.3.7 **Test during manufacture on all Components as applicable on insulator**

a) Chemical analysis of zinc used for galvanising:

Samples taken from the zinc ingot shall be chemically analyzed as per IS : 209. The purity of zinc shall not be less than 99.95%.

b) Chemical Analysis, mechanical hardness tests and magnetic particle inspection for malleable casting:

The chemical analysis, hardness tests and magnetic particle inspection for malleable casting will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Program.

1.3.8 Test during manufacture on all components as applicable on hardware fittings:

a) Chemical analysis of zinc used for galvanising:

Samples taken from the zinc ingot shall be chemically analyzed as per IS : 209. The purity of zinc shall not be less than 99.95%

b) Chemical analysis, hardness tests and magnetic particle for forgings:

The chemical analysis, hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

The chemical analysis, hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

c) Chemical analysis and mechanical hardness tests and magnetic particle inspection for fabricated hardware:

The chemical analysis, hardness tests and magnetic particle inspection for fabricated hardware will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance programme.

1.4 **Parameters**

1.4.1 **Disc Insulators** 400/220/132 kV

a)	Type of insulators	:	ANTI Fog type
b)	Size of insulator units (mm)	:	280x145
c)	Electro mechanical strength	:	120 kN
d)	Creepage distance of individual insulator units (minimum and as required to meet total creepage distance)	:	430 mm
e)	Markings	:	Markings on porcelain shall be printed and applied before firing
f)	Power frequency puncture withstand voltage	:	1.3 times the actual wet flashover voltage.

*Long rod insulators should conform to equivalent electrical and mechanical parameters.

1.4.2 **INSULATOR STRING**

		400kV	**220kV**	**132kV**
a)	Power frequency withstand : voltage of the complete string with Corona Control ring (wet) – kV rms	680	460	275
b)	Lightning impulse withstand : Voltage of string with corona control rings (dry) – kVp	±1550	±1050	±650
c)	Switching surge withstand : voltage of string with corona control rings (wet) – kVp	±1050	NA	NA
d)	Minimum corona extinction : voltage level of string with Corona Control rings (dry) - kV rms	320	156	NA
e)	RIV level in micro volts of string: with Corona Control rings at 320 kV (rms) for 400 kV string and 156 kV for 220 kV string across 300 Ohms resistor at 1 MHz	1000 (Max.)	1000 (Max.)	NA
f)	Total creepage distance of the : insulator string (mm)	10500	6125	3625
g)	Total no. of discs per strings :	25	15	10

For tension application, double insulator strings and for suspension purpose single suspension insulator string shall be used for 400 KV, 220 KV and 132KV system.

2.0 EARTHING

2.1 The earthing shall be done in accordance with requirements given hereunder and drawing titled 'Earthing Details' enclosed with the specification. The earthmat design shall be done by the Contractor as per IEEE-80. The soil resistivity measurement shall also be done by the Contractor. The resistivity measurement of stone (to be used for stone spreading) shall also be done by the Contractor. The resistivity measurement of stone (to be used for stone spreading) shall also be done by the Contractor to confirm the resistivity value of stone considered in earth mat design. For measurement purpose, one sample of stones from each source (in case stones are supplied from more than one source) shall be used. The main earthmat shall be laid in the switchyard area in accordance with the approved design requirements.

2.2 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metalworks associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

2.3 The earthing shall be done in accordance with requirements given hereunder and drawings. The Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing In the locality where the system is installed.

a) Code of Practice for Earthing IS:3043

b) Code of practice for the protection of Building and allied structures against lightning IS:2309.

c) Indian Electricity Rules 1956 with latest amendments.

d) National Electricity Safety code IEEE-80.

c)Conductor above ground & earthing leads (for columns & aux. structures)	75x12mm G.S. flat	Galvanised Steel
d)Earthing of indoor LT panels, Control panels and out door marshalling boxes, MOM boxes, Junction boxes & Lighting Panels etc.	50x6 mm G.S. flat	Galvanised Steel
e)Rod Earth Electrode. Pipe earth Electrode(in treated earth pit)as per IS	40mm dia, 3000mm long 40 mm diagalvised 3000 mm long steel	Mild Steel
f)Earthing for motors	25x3mmGS Flat	Galvanised steel
g)Earthing conductor along outdoor cable trenches	50x6MS	Mild steel Flat
h)Earthing of lighting poles	20 mm dia Mild steelrod3000 mm long	

The sizes of the earthing conductor indicated above are the minimum sizes

2.4

Details of Earthing System

2.5 Earthing Conductor Layout

2.5.1 Earthing conductors in outdoor areas shall be buried at least 600 mm below finished unless stated otherwise.

2.5.2 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.

2.5.3 Tap-connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure as per "Earthing Details".

2.5.4 Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding/cleating at intervals of 750 mm. Wherever it passes through walls, floors etc., galvanised iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

2.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location.

2.5.6 Earthing conductors crossing the road shall be laid 300 mm below road or at greater depth to suit the site conditions.

2.5.7 Earthing conductors embedded in the concrete shall have approximately 50 mm concrete cover.

2.6 Equipment and Structure Earthing

2.6.1 Earthing pads shall be provided for the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with Owner.

2.6.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of hand-rails and metallic stairs.

2.6.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

2.6.4 Metallic conduits shall not be used as earth continuity conductor.

2.6.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.

2.6.6 Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running alongwith the supply cable which inturn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.

2.6.7 Railway tracks within switchyard area shall be earthed at a spacing of 30m and also at both ends.

2.6.8 Earthing conductor shall be buried 2000 mm outside the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

The stone spreading shall also be done 2000 mm outside switchyard fence. The criterian for stone spreading shall be followed in line with requirement specified elsewhere in the specification

2.6.9 Flexible earthing connectors shall be provided for the moving parts.

2.6.10 All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules

2.6.11 A continuous ground conductor of 16 SWG GI wire shall be run all along each conduit run. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG ground conductor.

2.6.12 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Post Office red enamel paint.

2.6.13 A 40 mm dia , 3000 mm long MS earth electrode with test link , CI frame and cover shall be provided to connect down conductor of lightning mast and towers with peak.

2.7 Jointing

2.7.1 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/compound.

2.7.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red lead and afterwards coated with two layers bitumen compound to prevent corrosion.

2.7.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

2.7.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

2.7.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

2.7.6 Bending of earthing rod shall be done preferably by gas heating.

2.7.7 All arc welding with large dia. conductors shall be done with low hydrogen content electrodes.

2.7.8 The **75x12mm GS flat** shall be clamped with the equipment support structures at 1000mm interval.

2.8 Power Cable Earthing

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and swithgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

2.9 Specific Requirement for Earthing Systems

2.9.1 Each earthing lead from the neutral of the power transformer/Reactor shall be directly connected to two pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer/reactor like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.

2.9.2 Earthing terminal of each lightning arrester & capacitor voltage trasformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.

2.9.3 Auxiliary earthing mat comprising of 40mm dia M.S. rods closely spaced (300 mm x 300 mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M. Box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat.

3.0 Main Bus Bars

The brief description of the bus switching scheme, bus bar layout and equipment connection to be adopted are indicated elsewhere in the specification. The bus bar arrangements are shown in drgs enclosed with the bid documents.

3.1 The Contractor shall furnish supporting calculations for the bus bars/conductors to show adequacy of design parameters for:

a) Fibre-stress

b) Cantilever strength of post insulators

c) Aeolain vibrations

d) Vertical deflection of bus bars

e) Short circuit forces in bundle conductor and spacer location for each span of ACSR conductor stringing as per layout drawings.

3.1.1 The welds in the aluminium tubes shall be kept to the minimum and there shall not be more than one weld per span. The procedure and details of welding shall be subject to Owner's approval. Material for welding sleeve shall be same as that of Aluminium tube. Welding sleeve shall be of 600mm length

3.1.2 Corona bells shall be provided wherever the bus extends beyond the clamps and on free ends, for sealing the ends of the tubular conductor against rain and moisture and to reduce the electrostatic discharge loss at the end points. There shall be a small drain hole in the corona bell. The material of Corona bell shall be Aluminium alloy similar to that of clamps & connectors.

3.1.3 To minimise the vibrations in the aluminium tubes, damping conductor shall be provided inside the aluminium tubes. For this purpose, the cut pieces of ACSR conductor which otherwise are considered wastages, shall be used as damping conductor.

3.1.4 Details of past experience of the persons proposed to be employed for Aluminium tube welding and the test reports of the welded pieces to prove the electrical and mechanical characteristics shall also be furnished along with the bid. Welding at site shall be done by adopting a qualified procedure and employing qualified welders as per ASME-Section IX.

4.0 BAY EQUIPMENT

4.1 The disposition of various bay equipments shall be as per single line diagrams and layout drawings.

4.2 Bay Marshalling Kiosk:-One no. of bay marshalling kiosk shall be provided

for each bay. In addition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have three distinct compartments for the following purpose:-(i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distrubute minimum six (four in case of S/S having highest voltage 132kV) outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.

(ii) To distribute minimum ten (six in case of S/S having highest voltage 132kV) outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers

(iii) 200 (100 in case of S/S having highest voltage 132kV) nos. terminal blocks in vertical formation for intertocking facilities.

Additional marshalling Kiosk shall be provided incase the existing marshalling kiosks in a Diametre do not have adequate spare feeders.

5.0 LIGHTENING PROTECTION

5.1 Direct stroke lightning protection (DSLP) shall be provided in the EHV switchyard by lightning masts and shield wires. The layout drawings enclosed indicate the tentative arrangement. The final arrangement shall be decided after approval of the DSLP calculations.

5.2 The lightning protection system shall not be in direct contact with underground metallic service ducts and cab.

5.3 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

5.4 Down conductors shall be cleated on the structures at 2000 mm interval.

5.5 Connection between each down conductor and rod electrodes shall be made via test joint (pad type compression clamp) located approximately 1500 mm above ground level. The rod electrode shall be further joined with the main earthmat.

5.6 Lightning conductors shall not pass through or run inside G.I. conduits.

6.0 EQUIPMENT ERECTION DETAILS

6.1 For equipment interconnection, the surfaces of equipment terminal pads,

Aluminium tube, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, Aluminium tube/conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and the surfaces shall be cleaned properly after equipment interconnection.

6.2 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators .

6.3 All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.

6.4 Bending of Aluminium tube and compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

6.5 Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.

6.6 Handling of equipment shall be done strictly as per manufacturer's/supplier's instructions/instruction manual.

6.7 Handling equipment, sling ropes etc. should be tested periodically before erection for strength.

6.8 The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

7.0 STORAGE

7.1 The Contractor shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer/Owner shall be strictly adhered to.

8.0 CABLING MATERIAL

8.1 CABLE TAGS AND MARKERS

8.1.1 Each cable and conduit run shall be tagged with numbers that appear inthe cable and conduit schedule.

8.1.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

8.1.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.

8.1.4 Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable joints".

8.1.5 The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

8.1.6 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.

8.2 Cable Supports and Cable Tray Mounting Arrangements

8.2.1 The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.

8.2.2 The supports shall be fabricated from standard structural steel members.

8.2.3 Insert plates will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other places these will be at an interval of 2000 mm.

8.3 Cable Termination and Connections

8.3.1 The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/or as directed by the Owner.

8.3.2 The work shall include all clamping, fittings, fixing, plumbing, soldering,

drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

8.3.3 Supply of all consumable material shall be in the scope of Contractor.

8.3.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.

8.3.5 Control cable cores entering control panel/switch-gear/MCCB/MCC/ miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.

8.3.6 The Contractor shall tag/ferrule control cable cores at all terminations, as instructed by the Owner. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well.

8.3.7 Spare cores shall be similarly tagged with cable numbers and coiled up.

8.3.8 All cable entry points shall be sealed and made vermin and dust proof.Unused openings shall be effectively closed.

8.3.9 Double compression type nickel plated (coating thickness not less than 10 microns) brass cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof terminations.

8.3.10 The cable glands shall conform to BIS:6121. They shall comprise of heavy duty brass casting, machine finished and nickel plated, to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Cable glands shall be of approved make.

8.3.11 The cable glands shall also be suitable for dust proof and weather proof termination. The test procedure, if required, has to be discussed and agreed to between Owner and cable gland manufacturer.

8.3.12 If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor, as directed by the Owner.

8.3.13 Crimping tool used shall be of approved design and make.

8.3.14 Cable lugs shall be tinned copper solder less crimping type conforming to IS-8309 & 8394. Bimetallic lugs shall be used depending upon type of cables used.

8.3.15 Solder less crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

8.4 Storage and handling of Cable Drums

8.4.1 Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

8.5 DIRECTLY BURIED CABLES

8.5.1 The Contractor shall construct the cable trenches requried for directly buried cables. The scope of work shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and ramming, supply and installation of route markers and joint markers. The Bidder shall ascertain the soil conditions prevailing at site, before submitting the bid.The cable (power and control) between LT station, control room, DG set building and fire lighting pump house shall be laid in the buried cable trenches. In addition to the above, for lighting purpose also, buried cable trench can be used in outdoor area.

8.5.2 Cable route and joint markers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the marker.

9.0 INSTALLATION OF CABLES

9.1 Cabling in the control room shall be done on ladder type cable trays while cabling in switchyard area shall be done on angles in the trench.

9.2 All cables from bay cable trench to equipments including and all interpole cables (both power and control) for all equipment, shall be laid in PVC pipes of minimum 50 mm nominal outside diameter of class 4 as per IS 4985 which shall be buried in the ground at a depth of 250mm below finish formation level. Separate PVC pipes shall be laid for control and power cables.

9.3 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor. In the case of equipments located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all these cases necessary bending radius as recommended by the cable manufacturer shall be maintained.

9.4 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint. The red oxide and zinc chromate shall conform to IS:2074.

9.5 Suitable arrangement should be used between fixed pipe / cable trays and equipment terminal boxes, where vibration is anticipated.

9.6 Power and control cables in the cable trench shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried.

a) Power cables on top tiers.

b) Control instrumentation and other service cables in bottom tiers.

9.7 Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. All power cables shall be laid with a minimum centre to centre distance equal to twice the diameter of the cable of higher size of cables.

9.8 Trefoil clamps for single core cables shall be of pressure die cast aluminium (LM-6), Nylon -6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer etc. These are required at every 2 metre of cable runs.

9.9 Power and control cables shall be securely fixed to the trays/supports with self locking type nylon ties with deinterlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.

9.10 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows :

Table of Cable and	Minimum bending radius
Power cable	12 D
Control cable	10 D

D is overall diameter of cable

9.11 Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one metre depth.

9.12 In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables)/two (for H.T. cables) straight through joints to be made in case the cable develop fault at a later date.

9.13 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for by the drawings, unavoidable or where permitted by the Owner. If straight through joints are unavoidable, the Contractor shall use the straight through joints kit of reputed make.

9.14 Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.

9.15 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required by the Owner.

9.16 Rollers shall be used at intervals of about two metres while pulling cables.

9.17 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.

9.18 Cable ends shall be kept sealed to prevent damage. In cable vault, fire resistant seal shall be provided underneath the panels.

9.19 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS:1255 and other Indian Standard Codes of practices.

9.20 Wherever cable pass through floor or through wall openings or other partitions, GI/PVC wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the Contractor at no extra charges.

9.21 Contractor shall remove the RCC/Steel trench covers before taking up the work

and shall replace all the trench covers after the erection-work in that 9.21Contractor shall remove the RCC/steel covers before taking up the work and shall replace allthe trench covers after the erection work in thatparticular area is completed or when further work is not likely to be taken up for some time.

9.22 Contractor shall furnish three copies of the report on work carried out in a particular week, indicating cable numbers, date on which laid, actual length and route, testing carried out, terminations carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever any modifications are made.

9.23 Contractor shall paint the tray identification number on each run of trays at an interval of 10 m.

9.24 In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost to the satisfaction of the Owner. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to the Owner, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.

9.25 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

9.26 Cable trays

i) The cable trays shall be of G.S.sheet and minimum thickness of sheet shall be 2mm.

ii) The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.

a) Test for galvanising (Acceptance Test)
The test shall be done as per approved standards.

b) Deflection Test : (Type Test)

A 2.5 metre straight section of 300mm, 600mm wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall

be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

9.27 Conduits, Pipes and Duct Installation

9.27.1 Contractor shall supply and install all rigid conduits, mild steel pipes,flexible conduits, hume pipes etc. including all necessary sundry materials such as tees, elbows, check nuts, bushing, reducers, enlargers, coupling cap, nipples, gland sealing fittings, pull boxes etc as specified and to be shown in detailed drawing. The size of the conduit/pipe shall be selected on the basis of 40% fill criterion.

9.27.2 Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.

9.27.3 All conduit/pipes shall be extended on both sides of wall/floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by Contractor.

9.27.4 When two lengths of conduits are joined together through a coupling, running threads equal to twice the length of coupling shall be provided on each conduit to facilitate easy dismantling of two conduits.

9.27.5 Conduit installation shall be permanently connected to earth by means of special approved type of earthing clamps. GI pull wire of adequate size shall be laid in all conduits before installation.

9.27.6 Each conduit run shall be painted with its designation as indicated on the drawings such that it can be identified at each end.

9.27.7 Embedded conduits shall have a minimum concrete cover of 50 mm.

9.27.8 Conduit run sleeves shall be provided with the bushings at each end.

9.27.9 Metallic conduit runs at termination shall have two locknuts and a bushing for connection. Flexible conduits shall also be suitably clamped at each end with the help of bushings. Bushings shall have rounded edges so as not to damage the cables.

9.27.10 Where embedded conduits turn upwards from a slab or fill, the termination dimensions shown on the drawings, if any, shall be taken to represent the position of the straight extension of the conduit external to and immediately following the bend. At least one half of the arc length of the bend shall be embedded.

9.27.11 All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.

9.27.12 For underground runs, Contractor shall excavate and back fill as necessary.

9.27.12 Contractor shall supply, unload, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes, ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanised steel), caps, square headed male plugs, nipples, gland sealing fittings ,pull boxes, conduits terminal boxes, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits.

9.27.14 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.

9.27.15 Size of conduit for lighting shall be selected by the Contractor during detailed engineering.

9.27.16 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.

9.27.17 Conduit supports shall be provided at an interval of 750mm for horizontal runs and 1000mm for vertical runs.

9.27.18 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U- bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonary or concrete for conduit support is not acceptable.

9.27.19 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

9.27.20 Spacing of embedded conduits shall be such as to permit flow of concrete between them.

9.27.21 Where conduits are placed alongwith cable trays, they shall be clamped to supporting steel at an interval of 600mm.

9.27.22 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

9.27.23 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.

9.27.24 Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating devices etc. when it is evident that such proximity may reduce the service life of cables.

9.27.25 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.

9.27.26 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

9.27.27 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

9.27.28 Conduits joints and connections shall be made thoroughly water-tight and rust proof by application of a thread compound which insulates the joints. White lead issuitable for application on embedded conduit and red lead for exposed conduit.

9.27.29 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations of flattened surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.

9.27.30 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

9.27.31 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

9.27.32 Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

10.0 JUNCTION BOX

a) The Contractor shall supply and install junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for erection are also included in the scope of the Contractor.

b) Junction boxes having volume less than 1600 cubic centimeters may be installed without any support other than that resulting from connecting conduits where two or more rigid metallic conduits enter and accurately position the box. Boxes shall be installed so that they are level, plumb and properly aligned to present a pleasing appearance.

c) Boxes with volumes equal to or greater than 1600 cubic cm, and smaller boxes terminating on less than two rigid metallic conduits or for other reasons not rigidly held, shall be adequately supported by auxiliary steel of standard steel shapes or plates to be fabricated and installed. The Contractor shall perform all drilling, cutting, welding, shimming and bolting required for attachment of supports.

11.0 TESTING AND COMMISSIONING

11.1 An indicative list of tests for testing and commissioning is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./instructions of the equipment Contractor or Owner without any extra cost to the Owner. The Contractor shall arrange all equipments instruments and auxiliaries required for testing and commissioning of equipments alongwith calibration certificates and shall furnish the list of instruments to the Owner for approval.

11.2 GENERAL CHECKS

(a) Check for physical damage.

(b) Visual examination of zinc coating/plating.

(c) Check from name plate that all items are as per order/specification.

(d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.

(e) For oil filled equipment, check for oil leakage, if any. Also check oil level and top up wherever necessary.

(f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanised surfaces.

(g) Check cleanliness of insulator and bushings.

(h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.

(i) Check for surface finish of grading rings (Corona control ring).

(j) Pressure test on all pneumatic lines at 18.5 times the rated pressure shall be conducted.

11.3 STATION EARTHING

a) Check soil resistivity

b) Check continuity of grid wires

c) Check earth resistance of the entire grid as well as various sections of the same.

d) Check for weld joint and application of zinc rich paint on galvanised surfaces.

e) Dip test on earth conductor prior to use.

11.4 ALUMINIUM TUBE WELDING

a) Physical check

b) Millivolt drop test on all joints.

c) Dye penetration test & Radiography test on 10% sample basis on weld joints.

c) Test check on 5% sample joints after cutting the weld piece to observe any voids etc.

11.5 INSULATOR

Visual examination for finish, damage, creepage distance etc.

11.6 All pre/commissioning activities and works work for substation equipment shall be carried out as per specifications.

ANNEXURE "A"

Testing procedure for Galvanised Steel Earthwire

1. **UTS TEST**

Circles perpendicular to the axis of the earthwire shall be marked at two places on a sample of earthwire of minimum 5m length suitably compressed with dead end clamps at either end. The load shall be increased at steady rate upto 34 KN and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter, the load shall be increased at a steady rate of 68.4 KN and held for one minute. The earthwire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and value recorded.

2. **D.C. RESISTANCE TEST**

On an earthwire sample of minimum 5m length, two contact clamps shall be fixed with a predetermined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. the test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C shall conform to the requirements of this specification.

3. **Visual check for joints, scratches etc. and length of earthwire**

Earthwire drums shall be rewound in the presence of the inspector. The inspector shall visually check for joints, scratches etc. and see that the earthwire generally conforms to the requirements of this specification. The length of earthwire wound on the drum shall be measured with the help of counter meter during rewinding.

4. **TORSION AND ELONGATION TESTS**

The test procedure shall be as per relevant clause of IS:398 (Part-V). The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 64% or a gauge length of 200 mm.

5. **DIMENSIONAL CHECK**

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

6. **LAY LENGTH CHECK**

The lay length shall be checked to ensure that they conform to the requirements of this specification.

7. **GALVANISING TEST**

The test procedure shall as specified in IS:4826-1968. The material shall conform to the requirements of this specification.

8. **CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING**

Samples taken from zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

9. **CHEMICAL ANALYSIS OF STEEL**

Samples taken from steel ingots/coils/strands shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

ANNEXURE-B

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

2. Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by nosel meter

4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values.The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkeness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall lbe photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

In case corona inception does not take place at 130%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

4.1 The test shall be recorded on each photograph. Additonal photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser’s inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.

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4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

a) Background noise before and after test.

b) Detailed procedure of application of test voltage.

c) Measurements of RIV levels expressed in micro volts at each level.

d) Results and observations with regard to location and type of interference sources detected at each step.

e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.

f) Onset and extinction of visual corona for each of the four tests required shal

9 INSTRUMENT TRANSFORMERS

1.0 GENERAL :

1.1 The instrument transformers and accessories shall conform to the latest version of the standards specified below except to the extent explicitly modified in the specification and shall be in accordance with the requirements in specification and as per following IEC/ISS:

Current transformers IEC:44-1 (or IS:2705)

Voltage transformers IEC:186/358 (or IS:3156)

1.2 The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers.

1.3 The instrument transformer tank along with top metallics shall be hot dip galvanized.

1.4 The impregnation details along with tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.

1.5 The instrument transformers shall be designed for use in geographic and meteorological conditions as given in specification.

2.0 CONSTRUCTION FEATURES :

The features and constructional details of instrument transformers shall be in accordance with requirements stipulated hereunder :

2.1 **Bushing/Insulators:**

a) Instrument transformers shall be of 145 kV class, oil filled/SF6 gas filled, with shedded porcelain/composite bushings/Insulators suitable for outdoor service and upright mounting on steel structures.

b) Bushings/Insulators shall conform to requirements stipulated in specification. The bushing/insulator for CT shall be one piece without any metallic flange joint.

c) Bushings shall be provided with oil filling and drain plugs, oil sight glass of CT and for electromagnetic unit of CVT, etc. The bushing/insulator of instrument transformer shall have a cantilever strength of not less than 350 kg for 145 kV Instrument transformers or

as per the value obtained vide Chapter-GTR, whichever is higher. Oil filling and drain plugs are not required with SF6 gas filled CT.

d) Instruments transformers shall be hermetically sealed units. Bidder/ Manufacturer shall furnish details of the arrangements made for the sealing of instrument transformers along with the bid.

Bidder/Manufacturer shall also furnish the details of site tests to check the effectiveness of hermetic sealing for approval.

e) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

2.2 **Terminal box/Marshalling box :**

Terminal box shall conform to the requirements of specification.

2.3 **Insulating Oil :**

a) Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IS: 335 (required for first filling).

b) The SF6 gas shall comply with IEC-60376, 60376A and 60376B and shall be suitable in all respects for use in the switchgear under operating conditions.

2.4 **Name Plate :**

Name plate shall conform to the requirements of IEC incorporating the year of manufacture. The rated current, extended current rating in case of current transformers and rated voltage, voltage factor in case of voltage transformers shall be clearly indicated on the name plate. The rated thermal current in case of CT shall also be marked on the name plate.

The intermediate voltage in case of capacitor voltage transformer shall be indicated on the name plate.

3.0 CURRENT TRANSFORMERS :

a) Current transformers shall have single primary either ring type, or hair pin type and suitably designed for bringing out the secondary terminals in a weather proof (IP 55) terminal box at the bottom. These secondary terminals shall be terminated to stud type non disconnecting terminal blocks inside the terminal box. In case “Bar primary” inverted type current transformers are offered the manufacturer will meet following additional requirements :

(i) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.

(ii) The lowest part of the insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.

(iii) The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly & top dome.

(iv) Nitrogen if used for hermetic sealing (in case of live tank design) should not come in direct contact with oil.

(v) Bidder/Manufacturer shall recommend whether any special storage facility is required for spare CT.

b) Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.

c) Core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios with specified CT parameters.

d) The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil.

e) Facilities shall be provided at terminal blocks in the marshalling box for star delta formation, short circuiting and grounding of CT secondary terminals.

f) Current transformer's guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

g) For 145 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified in the specification.

h) For 145 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 10% to 100% of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

i) The current transformer shall be suitable for horizontal transportation. It shall be ensured that the CT is able to withstand all the stresses imposed on it while transporting and there shall be no damage in transit the Contractor shall submit the details of packing design to the Purchaser for review.

j) For 145 kV CTs the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In

case these are to be mounted separately these shall be mounted in the central marshalling box suitably wired upto the terminal blocks.

k) The wiring diagram plate for the interconnections of the three single phase CTs shall be provided inside the marshalling box. The Bidder/Manufacturer shall strictly adhere to it and deviations, if any, in this regard shall be brought out with justification for Purchaser's review.

l) The current transformers should be suitable for mounting on lattice support structure to be provided by the Contractor in accordance with stipulations of specification.

m) The CT shall be designed as to achieve the minimum risks of explosion in service. Bidder/Manufacturer shall bring out in his offer, the measures taken to achieve this.

n) 145 kV current transformers shall be suitable for high speed auto reclosing.

4.0 VOLTAGE TRANSFORMERS :

a) 145 kV Voltage transformers shall be **capacitor voltage divider** type with electromagnetic units and shall be suitable for carrier coupling.

b) Voltage transformers secondaries shall be protected by HRC cartridge type fuses for all the windings. In addition fuses shall be provided for the protection and metering windings for fuse monitoring scheme. Thesecondary terminals of the CVTs shall be terminated to the stud type non - disconnecting terminal blocks in the individual phase secondary boxes via the fuse.

c) CVTs shall be suitable for high frequency (HF) coupling required for power line carrier communication. Carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor suitable for effectively blocking the carrier signals over the entire carrier frequency range i.e. 40 to 500 KHz. Details of the arrangement shall be furnished along with the bid. H.F. terminal of the CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment, when utilised. Further earthing link with fastener to be provided for HF terminal.

d) The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal box with all the secondary terminals brought out.

e) The damping device which should be permanently connected to one of the secondary windings, should be capable of suppressing the ferroresonance oscillations.

f) The accuracy of 0.2 on secondary III should be maintained through out the entire burden range upto 50 VA for 145 kV CVTs on all the windings without any adjustments during operation.

g) 145 kV CVTs shall be suitable for mounting on tubular GI pipe in accordance with stipulations of specification or approved by BSEB.

h) It should be ensured that access to secondary terminals is without any danger of access to high voltage circuit.

i) A protective surge arrester shall be provided to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternate arrangement, bidder shall bring out the details in the bid.

j) The wiring diagram for the interconnection of the three single phase CVTs shall be provided inside the marshalling box in such a manner that it does not deteriorate with time. The Bidder/Manufacturer shall strictly adhere to it and deviations, if any, in this regard shall be brought out with justification for Purchaser's review.

5.0 TERMINAL CONNECTORS :

The terminal connectors shall meet the requirements as given in specification.

6.0 TESTS :

6.1 In accordance with the requirements in specification, Current and Voltage Transformers should have been type tested and shall be subjected to routine tests in accordance with IEC:44-1/IS:2705 and IEC:186/IS:3156 respectively.

6.2 The test reports of the type tests and the following additional type tests shall also be submitted for the Purchaser's review.

a) **Current transformers :**

i) Radio interference test as per Annexure-A of specification.

ii) Seismic withstand test as per Annexure-B of specification.

iii) Thermal stability test, i.e. application of rated voltage and rated extended thermal current simultaneously by synthetic test circuit.

iv) Thermal co-efficient test i.e. measurement of tan delta as a oo function of temperature (at ambient and between 80 C & 90 C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um/√3)

v) The current transformer shall be subjected to Fast Transient test by any one of the following two methods given below to assess the CT performance in service to withstand the high frequency over voltage generated due to closing & opening operation of isolators. Alternatively, method as per IEC:44-1 may be followed:

Method I: 600 negative polarity lightning impulses chopped on crest will be applied to current transformer. The opposite polarity amplitude must be limited to 50% of crest value when the wave is chopped. Impulse crest values will be 1000 kVp for 420 kV CTs. One impulse per minute shall be applied

and every 50 impulse high frequency currents form the windings and total current to earth will be recorded and be compared with reference currents recorded applying one or more (max 20) reduced chopped impulses of 50% of test value.

Oil samples will be taken before and 3 days after the test. Gas analysis must not show appreciable rate of increase in various gases related with the results of the analysis performed before test.

Total sum of crest values of current through secondaries must not exceed 5% of the crest value of total current to earth. CT must withstand dielectric tests after this test to pass the test.

Method II : 100 negative polarity impulses with a rise and fall time of less than 0.25 microsecond having 950 kV for 420 kV CT corrected to atmospheric condition shall be applied at one minute interval and total current through insulation of earth will be recorded. The amplitude of first opposite polarity should be limited to 50% of the chopped impulse crest value. Voltage and total current wave shapes shall be recorded after every 10 impulses, and will be compared with reference wave shapes recorded before test at 50% of test values.

Oil sample shall be taken before and 3 days after the test and CT shall be deemed to have passed the test if the increase in gas content before and after test is not appreciable.

b) **Voltage transformers:**

i) High frequency capacitance and equivalent series resistance measurement (as per IEC-358).

ii) Seismic withstand test (as per Annexure-B of specification).

iii) Stray capacitance and stray conductance measurement of the low voltage terminal (as per IEC-358).

iv) Determination of temperature coefficient test (as per IEC-358).

v) Radio interference test as per Annexure-A of specification.

vi) The Ferro-resonance type test shall be carried out on the complete CVT.

6.3 The current and voltage transformer shall be subjected to the following routine/site tests in addition to routine tests as per IEC/IS.

a) **CURRENT TRANSFORMERS :**

ROUTINE TESTS:

i) Measurement of Capacitance.

ii) High voltage power frequency withstand test on Secondary Winding.

iii) Over-voltage inter turn test (as per BS:3938).

iv) Oil leakage test.

v) Measurement of tan delta at 0.3, 0.7, 1.0 and 1.1 Um/√3.

vi) Measurement of partial discharge shall be carried out as per IEC.

SITE TESTS: Dissolved gas analysis to be carried out at the time of commissioning. CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere.

Bidder/Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. Bidder/Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.

b) **VOLTAGE TRANSFORMERS:**

i) Capacitance and loss angle measurement before and after voltage test (as per IEC:358).

ii) Partial discharge test on capacitor dividers (as per IEC-358).

Iii) Sealing test (as per IEC-358).

7.0 TECHNICAL PARAMETERS :

7.1 145 kV CURRENT TRANSFORMERS :

7.1.1	Rated Primary current	-600 A
7.1.2	Rated short time thermal current	31.5 kA for 1 sec.
7.1.3	Rated dynamic current	80 kA (peak)
7.1.4	Maximum temperature rise over design ambient temperature	As per IEC:44-1
7.1.5	One minute power frequency withstand voltage sec. terminal & earth	5 kV
7.1.6	Number of terminals	All terminals of control circuits are to be wired upto marshaling box plus 20% spare terminals evenly distributed on all TBs.
7.1.7	Type of insulation	Class A

7.2 **145 KV VOLTAGE TRANSFORMERS :**

7.2.1	System fault level	31.5 kA for 1 second
7.2.2	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measuremen
7.2.3	High frequency capacitance for entire carrier frequency range	
7.2.4	Equivalent series resistance over the entire carrier frequency range	Within 80% to 150% of rated capacitance Less than 40 ohms.
7.2.5	Stray capacitance and stray conductance of the LV terminal over entire carrier frequency range	
7.2.6	One minute power frequency withstand voltage	As per 1 IEC:358
	i) Between LV(HF) terminal and earth terminal	10 kV (rms) for exposed terminals and 4 KV (rms) for terminals enclosed in a weather proof box
	ii) For secondary winding	3 kV (rms)
7.2.7	Maximum temperature rise over Design ambient temperature	As per IEC:186
7.2.8	Number of terminals in control cabinet (interpole pole cabling is to be supplied by Purchaser)	All terminals of are wired upto marshaling box plus 12 terminals exclusively for Purchaser's use.
	Rated Total Thermal burden (VA)	
7.2.9	Voltage Transformers shall also comply with the Requirements of Table-IC of this Chapter	300 (100VA/winding)

.

8.0 **TESTING & COMMISSIONING**

8.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

8.2 **Current Transformers**

(a) Insulation Resistance Test for primary and secondary.

(b) Polarity test

(c) Ratio identification test - checking of all ratios on all cores by primary injection of current.

(d) Dielectric test of oil (wherever applicable).

(e) Magnetising characteristics test.

(f) Tan delta and capacitance measurement

(g) Secondary winding resistance measurement

8.3 **Voltage Transformers/Capacitive Voltage Transformers**

(a) Insulation Resistance test for primary (if applicable) and secondary winding.

(b) Polarity test

(c) Ratio test

(d) Dielectric test of oil (wherever applicable).

(e) Tan delta and capacitance measurement between :-(i)

HV - HF point

(ii) HF Point - Ground point of Intermediate Transformer.

(iii) HV - Ground point of Intermediate Transformer primary winding

(f) Secondary winding resistance measurement.

TABLE - IC REQUIREMENTS OF 145 KV CAPACITIVE VOLTAGE TRANSFORMERS

S.No.	PARTICULAR	DISCRIPTION		
1.	Rated primary voltage (kV rms)	145		
2.	Type	Single phase capacitor VT		
3.	No. of secondaries	3		
4.	Rated voltage factor	1.2 continuous 1.5 - 30 seconds		
5.	Phase angle error core)	± 20 minutes (For metering		
6.	Capacitance (pf)	8800 + 10%/-5%		
		Secon-dary I	Secon-dary II	Secondary III
7.	Voltage Ratio	132/0.11	132/0.11	132/0.11
8.	Application	Protec-tion	Protec-ing	Meter-tion
9.	Accuracy	3 P	3 P	0.2
10.	Output burden (VA) (minimum)	50	50	50

TABLE- II B REQUIREMENTS FOR 145 KV CURRENT TRANSFORMER

No. of Cores	Core No.	Application	Current Ratio	Outpur Burden (VA)	Accuracy Class as per IEC 44.1	Minimun Knee Pt. Voltage Vk	Max CT Sec. Winding Resistance (Ohms)	Max. Excitation Current at Vk (in mA)
5	1	BUS DIFF CHECK	600-300-150/1-1-1-1-1 A			600/300/150	6/3/1.5	30 on-600/1 60 on-300/1 Tap
	2	BUS DIFF MAIN	600-300-150/1-1-1-1-1 A			600/300/150	Tap 6/3/1.5	30 on-600/1 60 on-300/1 Tap
	3	METERING	600-300-150/1-1-1-1-1 A	20	0.2			30 on-600/1 60 on-300/1 Tap
	4	TRANS BACK UP/LINE PROTN	600-300-150/1-1-1-1-1 A			600/300/150	6/3/1.5	30 on 600/1 Taps 60 on 300/1 Tap
	5	TRANS. DIFF/LINE PROTN	600-300/1			600/300/150	6/3/1.5	30 on 600/1 Tap 60 on 300/1 Tap

All relative CTs shall be of accuracy class PS as per IS: 270

10. Sub-Station Structure

GENERAL TECHNICAL REQUIREMENT FOR SUB-STATION STRUCTURES

1 SCOPE OF SUPPLY

1.1 The scope of supply under this tender includes Sectionwise procurement of steel of proper quality from SAIL or 'I ISCO or IISCO-fabrication of steel structure as per general out line, galvanising these structures as per approved standard. The scope shall also include supply of GKW or Equivalent Standard Bolts, Nuts and washers and all fittings, base connection viz. anchor bolts Cleat, angle section and base platels etc.

1.2 SCOPE OF ERECTION

The scope of this tender also includes erection of sub-station structure. The sub-station structures shall be erected in accordance with the structural details and the erection diagram. This also includes the transportation of materials from local store to site, handling and stacking of material for erection.

2 DESIGN AND DRAWINGS

2.1. Tenderer will- furnish with tender set of the general out drawings for each type of structure to be fabricated. The detailed shop drawings will be developed by the supplier and the bill of materials for each type of structures will be furnished by the, supplier for the approval of the purchase before the structures are fabricated. Six copies of such bill of material shall be submitted to this office for approval.

2.2 Drawings will be in general to scale but the dimensional figures shall always be followed and drawings shall not be scaled. In case of discrepencies or ommission of diemension, the purchaser shall be

consulted for adjustment of any complications resulting there from. Bolts at joints may be staggered such that. the nuts may be tightened with spanner without fouling. Procurement of nuts and bolts shall be done by the supplier. Mechanical properties:- Shear stress-23.1OKg/Cm-Bending stress-4740Kg/Cm2

3 FABRICATION AND WORKMANSHIP

The fabrication of structures shall be in accordance with the following.

i) All parts shall be fabricated in accordance with the shop drawing approved by the purchaser

ii) The structure shall be of bolted construction unless otherwise specified, welding at any point shall not be permitted.

iii) The structure members, bolts, nuts, fittings shall be galvanised. Washer shall be electro galvanised.

iv) nd connections of all members carrying calculated stress shall be made by using not less than two bolts.

v) Normally butt splices shall be used, and thickness at the inside angle cleat shall not be less than that of the heavier member connected. Lap splices maybe used for connecting members of unequal size and the inside angle of lap splices shall be rounded at the heel to fit the fillet of the out side angle. All splieces shall develop full stress in the members connected through bolts as well as lap splices shall be made above and as close to the main pannel points as possible.

vi) Joints shall be so designed and detailed as to avoid eccentricity as for as possible. The use of gusset plates for jointing members shall be avoided as for as possible. However, where the connections: would-result into eccentric joints gusset plates or a combination of gusaet plate and appiar plates may be used in conformity with mordern practice.

vii) The use of fillers in connecton shall be avoided as for as possible. The diagnol web members in tension may be connecte4 entirely by gusset plate.where neccessary to avoid the use of fillers.

viii) The structure shall be accurately fabricated to bolt together easily on the site without any undue, strain on the members or in the bolts otherwise the structure of part of it. shall be rejected. No angle member shall have two legs brought together by cleating the member.

x) Bolts holes shall not be more than 1.5 mm larger than by corresponding bolt dimension.

xi) The structure shall be so designed that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets or depressions are likely to hold water, during rain.

xii) Workmanship and finish shall correspond to the best transmission line practice. All similar parts, shall be made stricitily interchangeable. All steel sections before any work is done on then shall be carefully levelled straightened and made true to method, which shall not injure the materials, so that when assembled to the advancent surfaces are in close contact throughout. No rough edges shall be permitted any where throughout the works.

DRILLING AND PUNCHING

4 a) All steel sections, before any cutting work is started shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued up after being, punched and drilled. No rough edges fresh froth shear shall be left. All sheared and out end shall be flawed ol'l'.

b) Holes for bolts shall be drilled or ,punched to jig but drilled holes shall be preferred. All holes in materials over 12mm. thick must be drilled through the plates and sections forming the joints in co-operation. Punched holes must be squared with the plates and the walls of the holes paralleled. The following maximum tolarance accurancy of punched holes are permissible.

i) Holes must be perfectly by ruler and no tolarance in this respect is permissible

ii) The maximum allowable difference in diameter of the holes in the two sides of the plates or angle is 0.8mm (1/32) i.e. the allowable taper in a punched hole should not exceed 0.8 mm (1/32) as diameter.

iii) All burrs left by drill or punch shall be removed completely. The supplier shall state clearely the extent of punching covered when the members are in position the holes shall be truly opposite to each other. Drifting remaining to enlarge defective holes shall not be permitted. End shall not be less than 19 mm for rolled edges and 22 mm for sheared edges and bolt holes whether punched or drilled must be larger than the sizes of bolts they have to take and shall not be more than 1.5 mm larger in diameter than the diameter of the bolts.

5.0 The steel required for the structure will have to be purchased by the firm from reputed manufacturers like 'I'ISCO, IISCO, SAIL etc.

6.0 **Slenderness ratios :**

The slenderness ratio (L/R) should not exceed the value given below:

1.) for leg members and other main members 125

i) All other compression members carrying stress 200

ii) For members having nominal or no stress 250

Stresses for steel manufactured regarding I.S.S. shall be as below :

i) Tension on net sectional area 2600 Kg/sq.cm.

ii) compression for cross sectional areas not exceeding 2600 Kg/sq.cm

1. **Splices.**

All splices should develop the full stress in the members connected through the bolts irrespective of the end bearing of the members. The members of the double web system designed for either tension or compression would not be spliced. Splices in all other web members should be avoided wherever possible.

II. **Leg member.**

For the leg angles butt splice should be used under the conditions and with details and strength requirements as per table - 3 annexed. The butt splices should be made at or above and as close the main panel points as possible. The thickness of the splice angle of butt splice should be that of the heavier members, fillers should not be used between the splice angle and the main members lap splices may be used at Points where the angles of adjacent member are of different dimensions.

III. **Galvanization**

Structure members, bolts, nuts fitting shall be hot dip galvanized except spring washer which shall be electro galvanized Galvanizing shall be done after fabrication completed but the nuts may be taped or return after galvanizing. Threads of bolts may be under if the bolts threads is not permitted.

Before galvanizing the steel section shall be thorough cleared of any point of grease, rust, scale, acid or alkali or such other foreign matter as so likely to interfere with galvanizing process or with the quality of durability of the zinc coating. Galvanizing of each member shall be carried out in one complete immersion. The galvanizing shall contain only the approved standard spelter.

The galvanizing shall be free from defects. During hot bath, steel section should not come in contact with material in bottom of spelter. Whipping & scrapping for removal of zinc not permitted. The kettle temperature must be controlled by pyrometers within class limit. The galvanized surface shall consist of continuous & uniform thick bright coating of zinc firmly adhering to the surface of steel. The finished surface shall be clear smooth and free from defects like discolored switches, bad spots, unvenesting, loose coating of zinc, spiky deposit of Zinc, blistered surface. In case of rejection & galvanizing,

previous surface should be cleaned and all zinc coating removed by said treatment & then re-galvanized

IV. Design criteria for structures.

i) Tension of bus bar and conductor

ii) Maximum tension - 1000 Kg.

span etc. As per general drawing.

iii) a) Wind pressure on conductor, Insulators

Earthiwire etc on projected area 95 Kg/m2

b) On 1.5 times of projected area of 195 Kg/M2

of structure.

V Temperature :-

Out door ambient temp.

Maximum …. 65 oC

Minimum 0oC

For long continuous structure such as multiply gantry structure temperature structures to be taken into considerations.

VI Combination of Loads for design of structures.

a) Real load of structure, wires, insulators & electrical equipment.

b) Wind load on structures, wires, insulators and electrical equipment.

c) Line loads

d) Liver load 300 Kg.

e) Direction of wind should be assumed for maximum stress in any member in combination of wind & line loads.

f) for bus structures., assume worst conditions & unbalance with all balancing taken off on opposite side of structures.

g) All other loads as per latest I.S.S

VII Facter of safety.

The factor of safety based on the crippling load or starts & elastic limit of tension member under condition of loading as discussed above should not be less than 2 for fabricated steel members.

VIII clearances :

The design of structure, should remit clearance from live parts above following minimum value after deflection of string wire on all wind.

220 KV	2082 mm
132 KV	1270 mm
33 KV	381 mm
25V	482 mm

IX Packing

The materials shall be boxed or bundled for transport in the following manner :-

a) Angles shall be packed in bundle securely wrapped four times around at each and every feet by wire having tightly twisted ends. Gross weight of any bundle shall not exceed approx. 450 Kg. and the length of the any individual member 6000 mm, normally except where necessitated in the drawing.

b) cleat angles brackets, filler plates and similar loose pieces shall be nested and bolted together with multiples and securely wired together through holes, wrapped round at least four times with no 5, swg. gauge wire and twisted tightly, Gross weight of each bundle shall not exceed approximately 70 Kg.

c) The correct number of bolts, nuts and washers plus five prevent extra for each structure has to be packed in heavy gunny bag, accurately tagged in accordance with the contents or number of bolts packed in a solid box of 22mm thick timber with paneled ends to be securely nailed and further reinforced with 22 mm x 55mm battens round the

sides at the ends with 25 mm. no. 10 SWG iron band stretched around the batons.

X MARKING OF PACKING :

The relevant marks and number or reference number of bolts, nuts and small components like gusset plates.

XI SAMPLES CHECK ASSEMBLY OF SUB-STATION STRUCTURES :

Before proceeding with the bulk fabrication of sub-station structure the contractor shall fabricate and assemble in his works for inspection by the purchaser one sub-station structure as finally approved by the purchaser for the purpose of checking the accuracy and workman ship. The check assembly shall be with the sub-station structure in horizontal position and not erected vertically. For the check assembly the bolts and nuts should be more than figure type.

11. CLAMPS AND CONNECTORS.

1. SCOPE

This section of the specification covers design, manufacture, testing at manufalcturer's works before despatch followed by supply and delivery of power connectors, bus bar, clamps etc for 132/33 KV grid s/ s complete in all respects.

2. STANDARDS

2.1 The clamps, spacers and connectors covered under this specification shall conform strictly to the provisions of the following Indian Standard Specifications as amended up to date except where specified otherwise in the specification:

a) IS: 5561-1970- Specification for electric power connector.

b) IS:2121-1981- Specification for fitting for Aluminium as amended Part-I & II and Steel cored Aluminium conductors for over head power lines. up-,to-date

c) IS:2633-1972- Methods for testing uniformity of coating on Zinc coated articles.

d) IS:2629-1966- Recommended practice for hot dip galvanising for Iron and Steel.

e) IS:617-1975- Specification for Aluminium and Aluminium alloy materials.

f) 1S: 1963-1967- Specification for Steels. g) IS.:1367-1961- Bolts and Nuts.

3 RATING

3.1 Normal current rating at the specified temperature of 50 degree C shall not be less than Current rating of ACSR condicutor in use

3.2 The minimum rated Short Time Current rating shall be taken as 31.5 KA for 1 sec for 132 KV. The connectors has to withstand the above current successfully for which test certificates from C.P.R.I, Bangalore or any other testing Laboratory recognised by Government has to be furnished with the tender. The current density to be considered in design shall not be more than 1.25-A per mm square.

4. MATERIAL:

4.1 All Aluminium and Aluminium alloy used in the manufacture shall conform to IS: 617-1975 (as amended upto date).

4.2 All bolts, nuts & washers shall be made from non-magnetic stainless steel and shall have bright finish: The holes of plain washer shall be reasonably concentric with outer perphery. All sharp edges shall be removed. Spring washers shall be supplied in natural finish.

4.3 The materials offered shall be of best quality and workmanship, free of blow holes and cracks, well finished and of approved design. The materials used in manufacture of the clamps and connectors should have high current carrying capacity, high corrosion resi$tar ee. The purity and composition of the materials shall have to be indicated in the tender. All connectors or its components to be connected with ACSR conductors shall have Aluminium purity not. less than 99.5% if these are compression type.

All bus bar camp shall be made preferably from forged Aluminium of purity not less than 99.5%. The thickness and-contact surface should be maintained in such way that the clamp should conform to IS:5561-1970 or any latest revision thereof.

Any terminal connector or its components other than those as mentioned above shall be manufactured from Aluminium Silicon alloy conforming to designation A6 of IS:6 17- 1 05O (latest version)

4.4 All ferrous metal parts except those made of stain less steel shall be protected by hot-dip galvanising in accordance with IS:2629-1966, as amended uptodate. Spring wsher where used shall be electro galvanised. The thread in nuts and in tapped holes shall be cut before galvanising and if required should be re-turned after galvanising.

5 DESIGN AND CONSTRUCTION:

5.1 The connectors shall be designed and proportioned so that they are capable of safely with standing' the stresses to which they may be subjected including those due to short circuits (Dynamic Force upto 300 Kg during short circuit) and stresses, due to climatic conditions, wind load etc. The effect of vibration both on the conductor and connectors itself shall be minimum. The connector shall be designed, manufactured and finished to avoid sharp radii of curvature, ridges, exerscences which might lead to localised pressure or damage to the conductor and connectors in service.

5.2 Supplier should provide Cold Rolled Aluminium Copper, bimetalic strip between the copper and Aluminium portion of the connection. The sheet thickness shall not be less than 2 mm.

5.3 Sufficient contact pressure should be maintained at the joint by provision of required number of bolts and nuts and other fixing arrangement. But the contact pressure should not be so great as to cause relaxation of the joint by cold flow. The joint should be such that the pressure is maintained within the range under all conditions of service. To avoid excessive local pressure, the contact pressure .should be evenly distributed by use of pressure plates, washers or suitable saddles of adequate area and thickness.

5.4 The current carrying parts shall be designed and manufactured such that contact resistance is reduced to the minimum. The resistance of the joint should be less than that of an equal length of conductor when measured individuwilly. Test Report showing the milivolt drop test and resistance should be enclosed with the tender.

5.5 All connectors shall be so designed and manufactured as 10 offer ease of installation as these are to be used in over head installations. Design of the connector will be such that full tightening of nuts & bolts should be possible without the use of double wrench.

The connectors shall be such as to avoid local corona sound or visible discharge.

6. TEMPERATURE RISE:

The temperature rise of power connectors while carrying the rated current shall not exceed 35 degree C over the ambient temperature of 50 degree C prevailing in the substation site.

If the ambient temperature exceeds as specified above, the permissible temp rise shall be reduced by an amount equal to the excess ambient temperature.

7. TEST

Following acceptance tests and routine tests shall be c«rried out on the clamps &. connectors as per IS:55C~ 1 ~c. lS:2633 in the works of manufacturer-. .

a) Routine test:	i)	Visual Inspection test.
	ii)	Dimensional check.
b)Acceptance test:	i)	Tensile test.
	ii)	Resistance test.
	iii)	Dimensional check.
	iv)	Galvanising test.

In case required by Purchaser, type test indicated below may also be performed for which no extra payment shall be done

c) Type:

i) Tensile test
ii) resistance test
iii) Temperature rise test.
iv) Short time Current test.
v) Salt spray test, .
vi) Galvanising test for Galvanised ferrous items.
vii) Visual Corna discharge test
viii) Dimensional test.

The reports of all the above mentioned tests carried out on each items shall be submitted for approval.

The Tenderers should have adequate testing facilities at their works to conduct all acceptanc dc and routine tests as required by relevant ISS at their costs. The tenderer may have to arrange type testing of clamps/connectors before finalisation of the tender at their cost.

Acceptance and routine test certificates as mutually agreed between the purchaser and the contractor based on any national standard will have to be furnished by the tenderer. These certificates will have to be got approved by the purchaser before supply of materials.

8. DRAWINGS:

8.1 Each tender shall be accompained with four sets of detailed dimensional drawings of the connectors offered. The drawings should show the elevation, crossection, longitudinal-section and plan of each item, tendered. The materials of each part to be manufactured shall be clearly indicated in the drawing. All dimensions must be in metric units, Schedule of drawings must accompany the tender.

8.2 Any manufacturing done prior to the approval of the drawings will be at the supplier's risk. The purchaser shall have the right to request the supplier to make any change in the design which may be necessary in

his opinion to make the equipments conform to the stated provisions and intent of these specifications without additional cost to the purchaser.

9. INTERCHANGEABILITY

Corresponding parts of similar clamps & connectors shall be interchangeable in every respects.

10. INSTRUCTION BOOKS/ CATALOGUES:

Applicable parts list, catalogues, operating and maintenance instructions in English/Hindi language especially prepared to cover all the equipment supplied under this specification which many be needed for assembling, Disassembling, repairs, identification of parts for ordering replacements, operation and maintenance, shall be collected in a common cover and submitted in twelve copies for each equipment to the purchaser free of cost. Such instruction booklets shall be supplied at least two months before actual dispatch of the equipment.

11. SAMPLES:

The tenderer will have to submit sample of each item for approval to purchaser before effecting supply and delivery of the ordered quantity of all items,

12. MARKING:

The equipment shall be eligibly and itidaliably marked with Trade mark of the manufacturer, country of manufacture and suitable identification mark as 13.S.E.Board.

All lables to be used on wooden boxes containing the clamp and connectors, shall be of tin securely bound with wire and shall have the descriptive marking stamped thereon.

13. Specific Technical particulars for the connector/ P.G.Clamps/Bus Support connectors.

1.	Rated current -	Equivalent of current rating of panther conductor.
2.	Rated frequency -	50 Hz
3.	Rated short time current.	25 KA for 3 sec (minimum)
4.	Aluminium Alloy to be used must conform to	IS617 :1975 (amended up to date)
5.	Stainless steel Bolts & NUTs conforming to	IS 1363 : 1967 &IS 1367-1961 (as amended up to date)
6.	Temp. rise of connectors and clamps above 50^{o}C ambient temp. shall not exceed	35^{o}C
7.	Protection against corrosion.	All parts shall either be inherently resistant to atmospheric condition or suitably protected against corrosion both during storage and in service.
8.	Tensile load Test. A) For connector B) For Tension clamps	A tensile load of 55 kg shall be applied and the conductor shall be marked in such a way that movement relative to the connectors shall be tested. without any subsequent adjustment on the connector, the load shall be steadily increased to 110Kg. This load shall be maintained for one minute. There shall be no movement of the conductor due to slip during this one minute period and no failure of the connector.
9.	Material	Forged Al. Alloy IS:617-1959 (As amended upto date)

10.	Make of bolts & nuts.	Tested Non magnetic stainless steel of requited make.

14. Offer for compression type Joints/clamps & connector

Clamps and connectors may be fixed by means of hydraulic tools with suitable dies. These dies should be manufactured from heat treated alloy steel. Dies will be supplied in line with the sizes of the conductors to be used i.e., ACSR "Panther" conductors.

The clamps & connectors should be made of forged Al. alloy suitable to with stand the load and stresses. Conductivity should not be less than the same length of the conductor.

12. HARDWARE FITTINGS

1 SCOPE :

This section of the specification covers the technical specification and other terms & condition design, manufacture, testing and supply of conductor/Earthwire accessories and hardware fittings as per details in specification.

2 STANDARD :

Design, Manufacture, Galvanised and Testing of conductor/Earthwire Accessories and hardware fittings shall conform to the following Indian Standard Specification as amended up to date.

IS:2121 – Specification for fittings for Aluminium and Steel cored Aluminium conductors.

IS:2486 – Specification for insulator fittings for over head power lines.

IS:209 – Specification for Zinc.

IS:2629 - Recommended practice for hot dip galvanized for Iron & Steel.

IS:2633 – Method for testing uniformity of zinc coating on hot dip zinc coated articles.

IS:9708 – Specification for Vibration dampers.

IS:2141 – (Part-II) Mid span compression joint.

IS:2141 – (Part-II) Specification for vibration damper.

3. TECHNICAL PARTICULARS :

(A) GENRAL REQUIREMENTS

Material offered shall be of best quality and workmanship. All casting shall be free from blow-holes, flaws, cracks or other defects and shall be smooth, close grained and of true forms and dimensions. All machined surfaces shall be true, smooth and well finished.

Metal fittings or drop forged steel or heat treated malleable cast iron for insulator string hardwares shall have excellent mechanical and electrical properties, such as strength, toughness and high corrosion resistance and free from corona formation. The material employed in the manufacture of accessories, viz aluminium, aluminium alloys, malleable iron, forged steel and stainless steel depending on

the types of application, shall be corrosion resistant and machinable.

Fittings and accessories shall be supplied complete in all respects, suitable for the proposed attachment and for the size of conductor and Earthwire for which they are to be used.

All bolts, nuts, screw heads shall be of the whitworth standard thread. Bolt heads and nuts shall be hexagonal. If required the nuts and tapped holes shall be cut out after galvanizing and shall be well lubricated/greased. All other threads shall be cut out before galvanizing. The bolt threads shall be under cut to take care increase in diameter due to galvanizing. Washers shall be electro galvanized.

The general design of hardware shall be such as to ensure uniformity, high strength, free from corona formation.

All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching insulators to the towers or to the line conductors shall be so designed as to reduce to minimum the damage to conductors, insulators or the fittings arising from the conductor vibrations.

Adequate bearing area between fittings shall be provided and point or line contact shall not be there.

All fittings shall be resistant to atmospheric corrosion and shall be suitably protected against corrosion both in storage and service.

The accessories shall be such as to avoid local corona formation or discharge likely to cause interference to either sound or vision transmission. Visible corona voltage of conductor accessories shall be greater than 11% or maximum line to neutral voltage of the line.

B) CONDUCTOR FITTINGS:

I) Compression type Mid span Joints.

Compression type mid span straight joints offered shall conform to technical particulars.

II) REPAIR SLEEVES :

Compression type repair sleeves shall be made of extruded aluminium and shall be suitable to provide reinforcement for conductor with broken or damaged aluminium strands. The repair sleeves shall be designed to make good conductor of which not more than 1/6 of the strands in the outer most layer are damaged/severed. The repair sleeves after compression should present smooth surface. The repair sleeves shall be so designed that conductivity of the joint shall not be less that 100% of that of conductor. Other details will be as per drawings and of technical particulars.

III) PREFORMED ARMOUR RODS:

Helically twisted formed armour rods offered shall be suitable for ACSR Panther conductors to provide rigidity an protection to the conductor at all the suspension points due to vibrations.

Armour rods shall be made of 99.6% pure electrolytic Aluminium or Aluminium alloy depending on the type of construction. The armour rods shall be marked in the centre suitable to indicate the commencement point of applying armour rods. No joint shall be permitted in the rods except those made in base rods before drawing. The armour rods shall be capable or being fixed by hand on the conductor without the aid of any tools or implements. The direction of spiral shall be the same as that of the conductor. The wires of the outer most layer of aluminium strands of the conductor shall have right hand lay. The loading stress of armour rods on the conductor shall be evenly distributed over the entire length and there shall be no tendency of loosening at the ends. Preformed armour rods shall not loose their resilience even after two or three applications. The rods should be capable of providing high self retaining strength and protection against vibration damage and fatigue failure of conductor. The ends should be properly ball ended. So that the danger of corona formation is avoided.

The surface of the armour rods when filled on the conductor, shall be smooth and free from protection cuts and abrasions etc. Dimentional sketch of the armour rod is enclosed with this specification.

IV) STOCK BRIDGE VIBRATION DAMPERS.

A dimensional sketch or the stock bridge 4R type vibration damper is attached with this specification Calculation and complete details of design, weight etc. of the damper shall be furnished with the tender together with the damping characteristics and energy dissipation curves of the dampers and guaranteed of their effectiveness for the specified conductor. For the purpose of these calculations, the design data shall be given in this specification. The offer is liable to be rejected in absence of the above details.

The vibration damper shall be of approved design. The clamp of the vibration damper shall be made of aluminium alloy, so designed as to prevent any damage to or chaffing of the conductor during erection or continued operation. If there is any chance of the clamp chaffing, the conductor while in service suitable aluminium liners, shall be provided. The messenger cable shall be made of high tensile strength steel strands and preformed in order to prevent subsequent drop of weights in service. The damper weight made of cast iron shall be attached to messenger cable by approved methods, clamping bolt shall be provided with self locking nuts.

All ferrous parts including the messenger cable, shall be hot dip galvanized. The ends of the messenger cable shall be effectively sealed to prevent corrosion. The vibration damper and its attachments shall have smooth surface, to avoid corona formation. The clamp of the stock bridge vibration damper shall be so designed that in case of loosening of the bolt or changing free part of the clamp it does not allow damper to disengage from the conductor.

C) INSULATOR HARDWARE FITTINGS :

The insulator hardware fittings for suspension and tension towers shall generally constitute of following components :-

i) Anchor shackle for ball hook for attachment or the suspension strings to tower hanger and tension strings to tower strain plates.

ii) Suitable yoke assembly for double suspension and double tension fittings.

iii) Suitable arching horns and fittings.

iv) Suspension/tension clamps.

v) Sag adjustment plates for dead end assembly.

vi) Other fittings i.e. eye links, chain link, ball clevises, socket clevis, eye clavicle, clevises etc.

vii) Bolts and nuts, washers split pins etc.

4.0 CLAMPS

A SUSPENSION CLAMPS

Suspension clamps offered shall be made of high strength aluminium alloy suitable for use with conductor with armour rod. The design shall be such as to avoid hot spot, Kicks cuts, Grooves projectors etc. Which are likely to damage conductor or lead to localized pressure, Clamps shall have satisfactory corona performance, no sharp radius or curvatures, ridge and excrescence etc, cotter pins, cotter bolts, U. Bolts, nuts, washers, etc. shall be made of galvanized steel. Split pins of suitable size and strength shall be made of brass. The clamps shall permit the conductor to slip before failure of the conductor and shall have sufficient slipping strength to resist conductor tension under broken wire conditions. It shall have sufficient contact surface to minimize damage due to fault current.

B TENSION CLAMPS :

Tension clamps shall be made of aluminium alloy and shall be of proper type. The clamps shall not permit, slip of any damage to or

failure of the conductor at a load of less than 95% of the ultimate strength of conductor. Mechanical efficiency of the clamp shall not be affected by method of erection involved. Come along or similar clamp during stringing operations.

C ARCHING HORN :

The Insulator hardware assembly shall have provision for fixing a set of arcing horns on the Insulator hardware fittings.

D VIBRATION DAMPERS :

Vibration damper shall be of stock bridge type having an aluminium alloy clamp compressed on the steel messenger strand between counter weights made of cast iron and shall be suitable for use on the overhead ground wire.

5. RAW MATERIALS :

Procurement of all raw materials for execution of this contract shall be done by the supplier at their own cost.

6. DRAWINGS :

The tenderer shall submit fully dimensioned drawings to scale indicating the materials of each part for dimension all under supply. The complete string drawing, both suspension and tension, shall indicate the over all length with its variations when subjected to tension as also the sparkover distance. The following arrangement of complete insulator strings and their component parts shall be clearly indicated.

Attachment to the tower hanger or strain plate.

Arcing Horn attachments.

Suitable ball and socket type fittings for interconnecting insulator units to the top and bottom clamps.

Detailed drawings of suspension and tension clamps indicating design adopted for preventing damage to the conductor & earthwire.

The material offered shall be in conformity with the purchaser's drawings attached with this specification. Any deviation from those drawings conforming to any other standard quoted by the tenderer will be subject to technical scrutiny by the Purchaser who shall have every right to accept or reject the same without assigning any reason thereof.

7. GALVANISING :

All ferrous metal parts except those made of stainless steel shall be galvanized in accordance with latest issue of IS:2629 or any other equivalent authoritative standard. The weight of zinc coating shall

conform to latest issue of IS:2633. The zinc used for galvanization shall conform to grade Zn-98 as per latest issue of IS:209. Spring washers, where used, shall be electro galvanized.

8. INTER CHANGEABILITY :

All hardware fitting and conductor accessories shall be of standard design and made to gauge of jig and shall be interchangeable in all respects with similar items.

9. TESTS/REPORTS :

Conductor accessories and hardware fittings will be subjected to all tests as per relevant Indian Standard Specification. The tests will be categorized in three grades, normally (i) Type. (ii) Acceptance Tests and (iii) Routine Tests.

TYPE TESTS :

Type Tests are normally carried out once and is not required to be carried out against all orders. Tenderers are, therefore to submit along with their offer reports in respect of Type Tests carried out as per provision of Indian Standard Specification by a reputed/recognized testing laboratory.

ACCEPTANCE TESTS :

These are such tests which are carried out for acceptance of material. This will constitute all tests as prescribed in the relevant Indian Standard Specification.

ROUTINE TESTS :

These are such tests which will apply to all fittings.

Reports in respect of all tests carried out during manufacture as per Indian Standard specification will be submitted to department for approval at the time material is offered for inspection.

Tenderers shall clearly state in their tender about testing facilities available in the laboratories at their works to confirm their ability to carry out all tests as per Indian Standard Specification.

Costs in carrying out any/all tests as above will be borne by the tenderer and will be included in their quoted price.

TECHNICAL PARTICULAR FOR HARDWARE FITTINGS:

1. Technical particular of ACSR Moose/Panther/Zebra conductor and Earthwire for which accessories and hardware fittings are required.

a) ACSR CONDUCTOR FOR TRANSMISSION LINE

ACSR panther conductor of composition 30/3.00 mm AL

b) EARTHWIRE

+ 7/3.00 st conforming in all respect to IS 398

+7/9 SWGGSS Earthwire of 110Kgf/mm2 quality conforming in all respect to IS:2141

2. Conductor accessories and hardware fitting for ACSR panther conductor (for use in 132 KV Line).

a) **M.S. comp. Joint**.

i)	Physical Dimension	-	As per approved drawing
ii)	Material specification	-	-do-
iii)	Minimum Failing strength	-	100% of UTS of ACSR panther conductor.
iv)	Slipping strength	-	95% of UTS of conductor.
v)	Electrical resistance Expressed as percentage Of measured resistance of Equivalent length of Conductor.	-	75%

b) REPAIR SLEEVE:

i)	Physical dimension	-	As per approved drawing/type test reports
ii)	Material a specification	-	-do-
iii)	Electrical Resistance Expressed as percentage of measured resistance of equivalent length of conductor	-	75%
iv)	Minimum failing strength	-	95% of U.T.S of ACSR panther

c) VIBRATION DAMPER

i)	Physical Dimension	-	As per type test reports
ii)	Material – a) Clamp	-	Aluminium alloy
a)	Messenger cable	-	High strength steel wire.
b)	Weight	-	Cast Iron

iii)	Galvaniastion.		
a)	Spring washers etc.	-	Electro galvanized.
b)	Other ferrous parts	-	Hot dip galvanised.
iv)	**SLIP STRENGTH OF DAMPER CLAMP.**		
a)	Before fatigue test	-	Not less than 250 Kg
b)	After fatigue test	-	Not less than 200 Kg
v)	Maximum permissible dynamic strain on conductor with damper		150 Micro strain
vi)	Minimum no. of cycles for fatigue performance.	-	Ten Million
vii)	Amplitude for fatigue ±1 MM at the highest resonance frequency.		
viii)	With velocity range for effectiveness of the damper	-	Upto 30 KV
ix)	Claimpul torque	-	Approx 6 Kg meter
x)	Normal span	-	350 Mtrs

d) Preformed armour rod

i)	Physical dimension	-	as per approved drawing
ii)	Reference	-	-do-
iii)	Material	-	99.6% Pure electrolytic A! or a1 alloy.
iv)	Tensile strength -	50,000 PSI	
v)	Conductivity	-	39% of inter national annealed copper strands.

e) Insulator hardware fittings

i) Specification of disc insulator for which Hardware fittings should match

		Suspension	**Tension**
i)	Type	Ball and socket	Ball and socket
ii)	Ball size	16 mm	16 mm
iii)	Disc Size	255 x 145 mm	255 x 145 mm
iv)	E.R. Strength	70 KN	90 KN

2.	Insulator string Arrangment.		
i)	Material	-	As per approved drawing
ii)	Dimension	-	As per approved drawing

iii)	String arrangement	-	As per approved drawing
iv)	Mechanical Strength (E.M Strength)	-	As per a approved drawing
v)	Reference Drawing	-	
i)	Single suspension	-	As per approved drawing
ii)	Double suspension	-	-do-
iii)	Single tension	-	-do-
iv)	Double Tension	-	-do-
3.	**CLAMPS.**		
i)	Material	-	As per approved drawing
ii)	Dimension	-	-do-
iii)	Mechanical strength	-	-do-
iv)	Slipping strength		
a)	Suspension	-	25% of UTS of Conductor
b)	Tension	-	95% of UTS of Conductor
v)	Angle of Inclination of Jumper terminal	-	30^0

3.Accessories and fitting for 7/9 SWG Earthwire.

a) **M.S. compression joint.**

i) Physical Dimension	As per approved drawing
ii) Material	As per approved drawing
iii) Minimum Failing strength	UTS of 7/9 SWG earth wire of 110 kgf/mm^2 quality.
iv) Reference drawing	As per approved drawing

b) **Vibration dumper.**

i) Physical dimension material.	As per approved drawing

c) **Suspension/Tension clamps with Flexible copper bond for 7/9 SWG earth wire**.

i) Physical dimension	As per approved drawing
ii) Material	-do-
iii) Slipping strength	
a) Suspension	25% UTS of E/W
b) Tension	95% UTS of E/W
iv) Minimum Failing load	
a) Suspension	UTS of E/W
b) Tension	UTS of E/W
v) Reference Draiwn.	

Suspension clamp	- As per approved drawing
Tension clamp	-do-

13. POST INSULATOR

1. SCOPE :

This specification covers the design manufacture. Testing at manufacturers works, supply and delivery F.O.R. destination of POST INSULATORS for use in outdoor grid substations of Bihar State Electricity Board.

2. STANDARDS :

The insulators covered under this specification shall comply with the requirements of latest edition of IS:2644-1973 or IEC-168-1964 (as amended upto date) except where specified otherwise in the specification.

3.1. DRAWINGS :

Drawings in quadruplicate incorporating the following particulars shall be submitted by each tenderer with the tender for the purpose of preliminary study.

(i) General outline drawing showing al dimension, net weights, shipping weights etc.

(ii) A copy of catalogue giving full details for the insulators.

(iii) Sectional views showing the general constructional features.

3.2 Within 15 days of the receipt of the order the tenderer shall submit the following drawings in quadruplicate for approval of the purchaser:

(a) Drawing showing details of insulators with dimensions.

(b) Assembly drawing showing the complete stacks/erected as desired for 132 kV systems, with full dimensions and accessories.

3.3 Tenderer may furnish any other drawing found necessary in addition to those stated above.

4. DESIGN AND GENERAL REQUIREMENT:

4.1 The post insulator unit shall have two metal parts, a cap partially embracing and insulating component and pedestal cemented into a recess in the insulating component. The cap shall have holes for retaining attachment bolts may pass.

The post insulator one unit or a number of units bolted together shall be designed to support and insulate high voltage busbars and isolators. These shall be designed to with stand tensile, torsional cantilever and compressive loads as specified in this specification.

Normally theses insulators shall be mounted uprist but in some cases other mounting arrangements may also be required for which the insulator shall also be designed.

4.2 The insulators shall be fabricated by the wet process. The insulating porcelain and the metal parts shall be assembled together with such materials and in such manner that any thermal expansion of the meal and the porcelain part through out the range of prating temperature shall not lesson the parts or create under stress adversely effecting the electrical and mechanical strength specified in the specification.

4.3 The post insulators shall be designed and manufactured in such a manner that the following are avoided:

a) Stresses due to expansion and contraction which may lead to deterioration in use.

b) Stress concentration due to direct engagement of the porcelain with metal fitting.

c) Shapes which do not facilitate easy cleaning by normal methods.

4.4 **PORCELAIN:**

The porcelain shall be sound, free from defects thoroughly vitrified and smoothly glazed. The glaze shall be brown in colour. The glaze shall cover all the exposed porcelain parts except those areas which serve as supports during firing or are required to be left unglazed. The unglazed part shall not have a total area exceeding.

5. MARKING :

Each insulator shall be legibly and indelibly market to show the following:

(a) Name of trademark of the manufacturer.

(b) Month and year of manufacture.

(c) Country of manufacture.

Marking on porcelain shall be printed and shall be applied before firing. In case in the insulators posses any ISI mark, the same shall also be printed.

6. CREEPAGE DISTANCE:

The tenderer shall specify in tender the creepage distance of the insulators.

The minimum distance, for insulators is specified in specification.

7. MECHANICAL LOADS:

The insulator shall be suitable for minimum failing loads specified in specification. Load shall be applied axially to the insulator stanch.

8. TEST:

8.1 TYPE TEST:

Type test are intended to demonstrate compliance of the design of the insulator with the requirements of specification. An insulator subjected to type tests may be unsuitable for subsequent use in service. Type tests shall be made on an insulator that has passed the routine test.

8.2. VISIBLE DISCHARGE TEST (POWER FREQUENCY VOLTAGE)

The test room shall be darkened and a period of five minutes shall be allowed for the observer to become accustomed to darkness. A power frequency test voltage specified in specification, shall be applied and maintained at this value for five minutes. During this test observation shall be made and there shall be no sign of visible corona.

8.3. IMPULSE VOLTAGE WITH STAND TEST:

The post insulator or post insulator units shall be tested dry with both positive and negative polarity unless it is known which polarity gives the lowest withstand value, in which case it is sufficient to test with that polarity. The value of impulse voltage shall be as specified in specification and shall be corrected for the atmospheric conditions given at section-III. Five consecutive impulse voltage waves shall be applied. If flash over or puncture does not occur, the insulator shall be considered to have passed the test. If during these five waves puncture occur or if two of the applied waves cause flashover through air, the insulator shall be considered to have failed. If only one of applied waves causes flash over through air, ten additional test waves should be applied. The insulator shall be considered to have passed this test only if flashover through air/or puncture does not occur for any of these additional 10 waves.

8.4. IMPULSE VOLTAGE FLASH OVER TEST:

The impulse generator shall be adjusted to deliver the require impulse wave. The 50 per cent impulse flash over voltage shall then be determined. At least 20 application near the required value shall be made to determine it with reasonable accuracy. The polarity shall then the reversed and 50 per cent flashover voltage for the opposite polarity measured in a similar manner.

The insulator shall not be damaged by these tests but slight marking on the surface of the insulating parts or obippug of the cement used for assembly shall be permitted.

The impulse flashover voltage to be recorded shall be the positive and negative 50 per cent impulse flashover voltage measured in accordance with and corrected in accordance with reference atmospheric condition.

8.5. DRY ONE MINUTE POWER FREQUENCY WITH STAND TEST:

The post insulator or post insulator units shall be tested at the value of test voltage specified in section-III. Suitable correction shall be done taking into account the atmospheric condition. The test voltage shall be applied for one minute. The insulator shall not flashover or puncture during the test.

8.6 WET ONE MINUTE POWER FREQUENCY WITHSTAND TEST:

The test object shall be subjected to a spray of water of prescribed resistivity given in the characteristics of the spray indicated below. The spray consisting of small drops shall fall on the test object at an angle of approximately 45^0 to the vertical as determined by visual observations, or by measurements of the vertical and horizontal components of the spray. These components shall be measured with a collecting vessel having a horizontal opening of area 100 to 750 Sq. cm. when both vertical and horizontal components are required, the horizontal components shall be measured with a collecting vessels having a similar vertical opening, located on the side of the test object facing the spraying nozzles and as close to the test object as is possible without collecting splases from it. The test object should be sprayed for at least one minute before the application of the voltage.

The characteristics of the spray shall be as given below:

Precipitation rate.	
(mm/min/vertical component)	3 10% ±
Resistivity of water	
(Ohm. Cm.)	10,000 10% ±
Temperature of water (0C)	Ambient 15 ±

The value of test voltage to be applied has been specified in section-III. Taking into account the atmospheric conditions, the test voltage shall be applied for one mounte. The insulator shall not flashover or puncture during the test.

The test voltaged shall then be gradually increased from about to per cent of the net one minute withstand voltage value to reach the flashover voltage in not less than 5 seconds.

8.7 POWER FREQUENCY PUNCTURE WITHSTAND TEST:

The insulators, after having been cleanded and dried, shall be completely immersed in a tank containing a suitable insulating medium to prevent surface discharges on them. If the tank be made of metal, its dimensions shall be such that the shortest distance between any part of the insulator and side of the tank is not less than 13 times the diameter of the largest insulator shed.

The test voltage shall be applied between those parts which normally have the operating voltage between them. During immersion in the insulation medium precautions shall be taken to avoid air pockets under the sheds of the insulator. The voltage shall be increased rapidly to the specified dry one minute power frequency test voltage and then rapidly increased at a rate of about 100 volts per second until the puncture withstand voltage is reached. No puncture shall occur at this voltage for the minimum time necessary to measure it.

8.8 MECHANICAL STRENGTH TEST:

Test post insulator or post insulator units shall be attached to the mounting face of the testing machine by its normal method of mounting. The

mechanical strength test of the post insulator or post insulator units shall in general consists of the test given in specification unless otherwise specified the test given shall be made.

8.9 BENDING TEST:

The load shall be applied to the free end of the post insulator or post insulator units. The direction of loading shall pass through the axis of the insulator and shall be at right angles to it. The load shall be applied gradually starting from a value not greater than half the specified minimum failing load and shall be increased until the specified minimum failing load is reached. The insulator shall pass the test if there is no failure it this load.

8.10 TORSION TEST:

The post insulator or post insulator unit shall be subjected to a tensional load avoiding all bending moment. The torsion test and load shall be applied gradually starting from a value not greater than half the specified minimum failing load and failure shall not take place below the specified minimum failing load. The load may then be increased to the failing load, which may be noted for information.

8.11 TENSILE OR COMPRESSION TEST:

The post insulator or post insulator units shall be subjected to a tensional or compression load along its axis. The tensile or compression load shall be applied gradually starting from a value not greater than half the specified minimum failing load. The load may then be incensed to the failing load which may be noted for information.

9. SAMPLE TEST:

Suitable number of individual post insulators and complete units or one unit solid core shall be subjected to tests as per IS-2544-1973 or any other equivalent authoritative standard.

The insulators after having withstand the routine test shall be subjected to the following tests in order as indicated below:

10. VERIFICATION OF DIMENSIONS:

It shall be verified that the post insulator or post insulator units in accordance with the relevant drawings tolerance of (0.3d 0.3) mm shall be allowed for all dimension and the dimension should be in millimeters.

11. TEMPERNTURE CYCLE TEST:

The insulator shall be completely an quickly immersed in a water bath maintained at a temperature of the degree centigrade given in the table above that of the cold water and left submerged for T minutes where T (15 0.7M) M being the mass of the insulator in Kg. It shall then be withdrawn and quickly and completely immersed without being placed in an intermediate container in a bath of cold water or the same period to T minutes.

Table Temp, difference in degree.

Volume D^2L	Temperature Up to over 23 23 Up to 26	Difference over 26 up to 32	T deg. For Over 32 up to 36	Thickness Over 36 up to 43		Over 40
Up to 0.164 over	60	55	50	45	45	35
0.410/0.164 up to 55 over	55	55	50	45	40	35
0.655/0.410 up to 50 over	50	50	50	45	35	35
0.900/0.655 up to over	45	45	45	45	40	35
1.105/0.900 up to over	40	40	40	40	40	35
Over 1.150	35	35	35	35	35	35

L = The greatest external diameter of the insulators.

L = The height of the insulator.

Notes :- The thickness shall be the greatest thickness of the insulator as defind as the diameter of the biggest section through the axis of the insulator.

12. The completes test shall comprise five transfer cold to hot, hot to cold, cold to hot, hot to cold, cold to hot. The time taken to transfer the insulator from one bath to the other shall be as short as possible and shall not exceed 30 second. The quantity of water in the test tank shall be large enough not to cause a temperature variation of more than 5^0 in the water when the insulator is immersed.

After the completion of immersion, the insulator shall be examined to verify that the immolating parts have not cracked nor the fittings are loosened and that the glass is undamaged.

13. POWER FREQUENCY PUNCTURE WITHSTAND TEST:

The test given in 8.7 shall be carried out. If one or more samples fail to comply with the requirement of this test, a test in accordance with 16 shall be made.

14. POROSITY TEST:

Porcelain fragments from the insulator or by agreement from representative pieces of porcelain fired adjacent to them, shall be immersed in one per cent alcoholic solutions of funchumim (ig funchsin in 100g of methylated spirit) under a pressure of notless than 150 Kg/Cm^2 for a period such that the product of test duration in hour and the test pressure in Kg/Cm^2 is not less than 1800.

The fragments shall then be removed from the solution, washed, grid and broken, Examination with naked eye of the fresh broken surface shall not reveal any dye penetration. Ponetration in small cracks formed during the intial breaking shall be neglected.

15. GALVANISATION TEST:

The galvanized metal fittings of the insulator shall comply with the test given in IS 728-1956 method of determination of weight thickness and uniformity of coating on galvanized articles other than wire and sheets. If one or more samples fail to.

If one or more samples fail to comply with the requirement of this test a retest in accordance with 2.21.16 shall be made.

16. RETEST AND REJECTION:

If only one insulator or meta part fails to comply with anyone of the tests given in specification a new quantity equal to twice the first quantity shall be subjected to retesting. The retesting shall comprise the test in which failure occurred preceded by those tests which may be considered to have influenced the result of the original tests. If no failure occurs, the lot shall be O.K.

If two or more insulators or metal parts fail to comply with any of the tests given in specification or if any failure occurs on insulators or metal parts subjected to retesting as in specification, complete lot shall be with drawn for the further examination by the manufacturer after which the lot or may part thereof may be resubmitted for tests. The number then selected shall be three times the first quantity chosen for test. This retesting shall comprise the test in which the failure occurred preceded by those test which may be considered to have influenced. There sults or the original tests.

17. ROUTINE TEST:

Routine tests shall be conducted on every insulator as per the order given below:

18. VISUAL EXAMINATION:

A visual examination of the insulator shall be made. The insulator shall be free from physical distortion of shape and the vitrified glaze shall be hard and smooth and free from cracks or any other defect likely to be prejudicial to satisfactory performance in service, with exception of area serving as supports during firing are left unglazed for the purpose of assembly the unglazed face shall not come a total area exceeding.

$$1 + \frac{DL}{1000} \text{ Cm. Square.}$$

Where D = greatest external diameter.

L = Height of the insulator.

Also the area of any single defect shall not exceed:

$$0.5 + \frac{DL}{1000 \text{ Cm. Square.}}$$

Such unglazed area shall be already shown in the drawing submitted by the manufacturer.

19. MECHANICAL TEST:

Every post insulator unit shall be subjected to a mechanical test at a load not less than 10 per cent of the specified tensile failing load of the unit. The load shall be maintained for at least 3 Sec. minimum without damage to the insulator or loosening of fitting. Insulators with broker whose metal parts are fractured or become detached during the test shall be rejected. If it exceeds 5 per cent of the lot, the lot shall be rejected.

20. ELECTRICAL TEST:

Post insulator unit shall be subjected to the power frequency. The test voltage shall be such as to produce frequent flashover (every few secs). The voltage shall be maintained for a minimum period of five minutes or if failures occur for five minute after the last punctured piece has been removed. Insulators which

are damaged during the test shall be rejected stream or pattern formed during electrical tests may be observable, but it shall not disqualify the insulator for acceptance.

SPECIFIC TECHNICAL REQUIREMENTS FOR POST INSULATORS

21. SCOPE :

The section covers the specific technical particulars, system particular suiting to which the post insulators shall be offered as per the General Technical Specifications and schedule of requirements specified herein

22. TYPE AND RATING :

22.1 The insulators offered shall be stacking type post insulator with cap and pedestal suitable for 132K system.

22.2 The insulators offered shall fulfil the following technical requirements :-

1. Type	Stacking type post insulator with cap and pedestal.
2. System Earthing	Effectively Earthed.
3. Rated system frequency	50 CPS

4. Nominal system voltage in KV (RMS)	33	22
5.Highest system voltage in KV (RMS)	36	24
6. Basic insulation level in KVP	200	170
7. Minium creepage distance in mm		
(i) Total	850	430
(ii) Protected	425	215
Cantilever strength in Kg.		
(i) Up right	3200	920
(ii) Inverted	1820	680
8. Tensile strength in Kg	9100	4500
9. Torsional strength in Kgfm	520	92
10. Height of each insulator (minimum) in mm	368	254
11. Bolt circle diameter in mm	127	76
12. Visible discharge test voltage (Power frequency) in KV (RMS)	27	18
13. One minute power frequency with stand test voltage in KV (RMS)		
(i) Dry	130	90
(ii) Wet	85	56
14. Impulse voltage with stand test voltage in KVP	210	125

3.19.3 Technical Particulars of 33KV Post Insulator's to be used in 132 KV system Stacking Type

1.	Dimensions For	132 KV System
(i)	Height of mm for each insulator	368
(ii)	Height of insulator stack in mm. (Solid dore)	1472
(iii)	Bolt Circle Diameter in mm	127
(iv)	Creepage distance in mm	
(i)	Total	3400
(ii)	Protected	1700
(v)	Cantilever strangth in kg.	
(i)	Upright	550

(ii)	Inverted		400
(iii)	Tensile strength in kg		9100
(iv)	Torsional strength		520
(v)	Power Frequency flashover	Dry	275
	Voltage in KV (RMS)	Wet	275
(vi)	Impulse flash over in KV (peak)		750
(vii)	Visible discharge Test Voltage power frequency in KV (rms)		105
(viii)	Number of Insulators to Be used for stacking type.		4 Unit Stack

14. CIVIL WORK

1. GENERAL :

The details of scope of civil work related to the completion of construction of two no. 132 kV bay at Grid Sub station Mathurapur and 132 kV D/C (3 phase strung) transmission lineon to feed power to New Karawandiya TSS . This detailed scope of work will include all those works which are not specifically mentioned here but are technically or otherwise required and unavoidable for the commissioning of the Project.

1. SCOPE OF WORK

The Scope of work broadly covers the works as required for the construction of two No 132 Kv bays as per BSEB specifications and latest practices adopted by BSEB. These works include design and engineering to be done by the Contractor for all new works including Civil works stated above.
Ordering authority reserves the full right to change or alter any scope of work at any time without assigning any reason.

All the clearances related to performing all the scope of works shall be obtained by the tenderer/contractor and the purchaser shall extend all necessary help in this regard.

3. SITE CONDITIONS

The tenderer/Contractor shall familiarize himself with site conditions, general arrangements at Grid Sub- Stations and Schemes etc. The purchaser shall assist the Contractor to the extent possible in obtaining the required information but it shall not be binding on the purchaser to provide the same. The tenderers are necessarily required to visit the Sub- Station sites to acquaint themselves with the topography,

infrastructure, design and to collect the required inputs so as to access the requirement of total work for completion of the specified scope. The tenderer shall be fully responsible for providing all equipments, materials, systems and services specified or otherwise which are required to complete the work, construction and successful commissioning, operation and maintenance of the specified work in all respects.

4. All materials required for Civil Construction, installation and commissioning works, including the supply of all labour and materials viz Cement, Steel, aggregate and Bricks etc for the above works, shall be supplied by the Contractors and shall be of best quality.

5 The complete design and detail engineering shall be done by the Contractor based on the best prevalent technology and practices. All the works and structure shall be able to be utilized and meet the requirements.

6. The Contractors shall be responsible for the overall co-ordinations with Boards officials, internal/external agencies, Project management, training of the Boards manpower, loading, unloading, handling, storing including Board's supplied materials (if applicable) for successful construction erection, testing and commissioning of the Switchyard.

7. QUANTITIES

The bidder is required to estimate the quantity of each item of work required for entire execution and completion of that particular item/works and incorporate the price in respective price schedules.

8. The earth mat design shall be based on measurement of Soil resistivity to be taken by the contractor in the adjoining/near by vacant area since correct soil resistivity value can not be obtained in the existing switchyard area. Earth mat shall be designed for area as and where required.

9. OTHER CIVIL WORKS

The Contractor shall furnish all labour, tools, equipments, materials, temporary work shops, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the works in accordance with drawings, specifications and direction of Engineer in charge.

All materials including Cement, reinforcement steel and structural Steel etc. shall be arranged by the contractor. All testing equipments shall be arranged by the contractor at his own cost and conveyance the bidder shall fully apprise himself of the prevailing conditions at the proposed site conditions including Monsoon patterns, local conditions

including law and order and contingent measures in the bid, including those, which may not have been specifically brought out in the specifications**.**

12.1 Tower & equipment foundations with cable trenches.

All construction drawings for towers and equipments foundations shall conform to the BSEB Design. Drawings for any non-standard tower or equipment foundation, if required, shall be designed by the Contractor and made available to the purchaser during detailed Engineering. Foundations for any miscellaneous requirements like electric poles, the Contractor shall engineer kiosks etc. and the design and drawings shall be submitted for owner's approval.

CABLE TRENCHES

All the cable trenches have to be constructed with 6" thick minimum R.C.C. wall having 6" wide 6 mm thick mild steel plate lugs fixed in the walls @ 3 meter c/c to support the cable trays. The entire length of the trench shall be covered with 6" thick R.C.C. (M-20) cover having at least 75 mm bearing each side over the trench wall of 6" thickness. The top of trench and cover slab should be flushed to give monolithic look. M.S. Gratings should be provided over trenches after every 10 covers slabs. In case of any deviations from the Boards Standard design and drawing, Prior approval for the same may be taken.In case the site conditions warrant any special type of foundation for any equipment to be used, the same shall be designed and taken in to the scope of work during detailed engineering.

12.5 Tower and equipment structures.

The structures shall conform to the BSEB's approved design and drawings suitable modification shall be carried out in the drawings of equipment support structures by the contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, control cabinets, junction box, surge counter etc. in the standard structure fabrication drawings. The contractor shall submit drawings of fixing of such accessories for approval.

15. DISC INSULATORS

1.0 SCOPE:

This section of the specification covers the technical specifications for design, manufacture, testing and supply of Disc Insulators for use in high voltage over head transmission lines.

2.0 STANDARDS:

The design, manufacture, galvanizing & testing of insulator disc shall conform to the following Indian Standard specification, as amended up-to-date, except where specified otherwise:-

i) IS: 731:1971 – Specification of porcelain insulators for overhead power lines with a Nominal voltage greater than 1000V.

ii)IS: 2629-1966 – "Recommended practice for Hot Dip Galvanizing of Iron & Steel"

iii) IS: 2633-1972 – "Methods for testing uniformity of coating on zinc coated Articles".

iv) IS:209 – "Specification for zinc".

3.0 MATERIAL:

3.1 The material offered shall be of first class quality, work, man ship, well finished and of approved design. All casting shall be free from blow-holes, flaws,

cracks or other defects and shall be smooth, close-grained and of true forms and dimensions.

All machined surfaces shall be true, smooth and well-finished.

.

3.2 Metal fittings of drop forged steel or head treated malleable cast iron, for insulators are required to have excellent mechanical properties such as strength, toughness and high corrosion resistance and free form corona formation.

3.3 Cement used in the construction of insulators shall not cause fracture by expansion or loosening by contraction and must have high compressive and shearing strength and be free from change in volume due to ageing and temperature change.

4.0 DESIGN AND TYPE:

4.1 The disc shall be cap and pin type with ball and socket coupling. The caps and pin of the disc insulators shall be heavily galvanized and mechanically strong. The pin balls shall move freely in the cap sockets, but shall be so design that they do not disengage while in services.

4.2 The caps shall be made of heat treated malleable cast iron. These shall be free from cracks, shrinks, air holes, burns and rough edges. The caps shall be circular, with inner and outer surfaces, concentric and of such design that they will not yield or distort under any stress to the porcelain shells.

4.3 The standard designation of the ball size (Nominal Pin Shank Diameter), the coupling dimensions and mechanical strength rating shall be in accordance with IS: 2486 (Part-II) 1974.

4.4 Security clips for use with ball and socket coupling and split pins for use with cotter bolts, shall be made of phosphor-bronze. The security clip shall provide positive look-in accordance with IEC Recommendation publication No. 372-1(1972). The legs of the security clips shall be spread after installation to prevent withdrawal from the stacked. The locking devices should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in Position. Under no circumstances shall the locking device allow separation of insulator units or fitting device allow separation of insulator units or fittings.

4.5 Visible Corona Discharge Voltage: Visible corona discharge voltage of Insulators shall be greater than 110 percent of maximum line to neutral voltage of the line.

5.0 REQUIREMENT OF INSULATOR STRING ASSEMBLES:

The insulator discs, offered by the bidder, shall be suitable to meet te requirement given in specification.

5.1 DRAWINGS:

1) The tenderers shall submit fully dimensioned drawings to scale indicating *the material of each part of all the items offered by them.*

5.2 INTER CHANGEABILITY:

The insulators including ball and socket coupling shall be of standard design and made to gauge or jig and shall be interchangeable in all respect with similar items.

5.3 HOT LINE MAINTENANCE :

The insulators shall be suitable for employing hot line maintenance techniques with requisite speed, case and safety.

5.4 TESTS AND REPORTS:

Requisite number of individual insulator units shall be subjected to all tests as per relevant Indian Standard Specifications. In general all the tests to be carried out will be categorized in three groups, namely.

a) Type tests.
b) Acceptance tests &
c) Routine tests.

5.4.1 TYPE TESTS :

These tests are carried out to prove conformity with the specification. These are intended to prove the general qualities and design of a given type of insulator.

Type tests are normally carried out once and are required to be carried out against all orders. Tenderer are, therefore, requested to submit along with their offer test reports in respect of type tests carried out as per provision of I.S.S. by a

reputed/recognized testing laboratory on not less than two insulators of each of the offered items.

The following tests shall constitute the type tests:-

i) Visual examination

ii) Verification of dimensions.

iii) Visible discharge test.

iv) Impulse voltage withstand test.

v) Wet power frequency withstand test.

vi) Temperature cycle test.

vii) 24 hours mechanical strength test.

viii) Electro mechanical failing load test.(For-U type insulators only)

ix) Mechanical failing load test (For B-type string insulators only).

x) Porosity test.

xi) Puncture test.

xii) Galvanizing test.

5.4.2 ACCEPTANCE TESTS :

These tests are carried out on samples taken from the lot for the purpose of acceptance of the lot. The test samples shall be subjected to the following acceptance tests:-

i) Verification of dimensions

ii) Temperature cycle test

iii) 24 hours mechanical strength test

iv) Electro mechanical failing load test (for string insulation units. Type-B only)

v) Mechanical failing load test (For string insulation units, Type-A rigid insulator only)

vi) Puncher test (For Type-B only)

vii) Porosity test.

viii) Galvanizing test.

5.4.3 ROUTINE TESTS :

These tests are carried out on each insulator to check the requirements which are likely to vary during manufactures. The following tests shall be carried out as routine tests.

i) Visual examination

ii) Mechanical routine test.

iii) Electrical routine test.

Test reports in three copies in respect of all routine tests carried out during manufacture as per relevant I.S.S. will be submitted to the department for approval at the time material is offered for inspection.

5.4.4 The tenderers shall clearly state in their offer, the testing facilities available in the laboratories at their works to confirm their ability to carry out all tests as per Indian Standard Specification. All the costs involved in carrying out the specified tests will be borne by the tenderers.

5.5 **MARKING:**

Each insulator shall be legibly and indelibly marked to show the following:

i) Name of trade mark of the manufacturer

ii) Months & year of manufacture

iii) Minimum failing load in Newton's.

iv) Country of manufacture &

v) ISI certification Mark

Marking on porcelain shall be printed and shall be applied before firing.

5.6 PACKING :

The insulator discs shall be supplied duly packed in strong wooden crates or boxes of approved design with steel loop & bands for strength & durability to withstand rough handling during transportation, loading, un-loading, storage and hardening in field.

Each Crate/Box shall have the following markings in indelible ink or stamped thereon:-

i) Manufacture's name

ii) Purchaser's name

iii) Name & designation of consignee

iv) Size/type(EMS) of insulators and quantity.

v) Indication for careful handling

6.0 SEPECIFIC TECHNICAL PARTICULARS FOR DISC INSULATORS

Particulars	Suspension	Tension	Tension
	(70 KN)	(90 KN)	120 KN
(i) Type:	Ball & Socket	Ball & Socket	Ball & Socket
(ii) Diameter :	255 mm	255 mm	255 mm
(iii) Spacing :	145 mm	145 mm	145 mm
(iv) Colour:	Brown	Brown	Brown
(v) Surface:	Glazed	Glazed	Glazed
(vi) E.M. Strength:	70 KN	90 KN	120 KN
(vii) Impulse withstand test voltage.	110 KV	110KV	110 KV
(viii) Dry Impulse Flashover voltage + ve wave. :	125 KV	125 KV	125 KV
(ix) Dry Impulse Flashover voltage-ve wave.:	137 KV	137 KV	137 KV
(x) Power frequency one minute dry flashover voltage:	80 KV	80 KV	80 KV
(xi) Power frequency wet flashover voltage	50 KV	50 KV	50 KV
(xii) Power frequency puncture withstand test voltage:	1.3 time the actual flashover voltage of the unit.		
(xiii) Power frequency one minute dry withstand voltage.:	75 KV	75 KV	75 KV
(xiv) Power frequency one minute wet withstand voltage.:	45 KV	45 KV	45 KV
(xv) Visible discharge test voltage.	154 KV	154 KV	154 KV
(xvi) Creepage distance (min)	280 mm	280 mm	280 mm
(xvii) Minimum failing load :	Same as EMS indicated above.		
(xviii) Ball and socket designation Of insulator disc :	16mm/ 20mm as per IS-2486 Part-II, 1974	16mm/ 20mm as per IS-2486 Part-II, 1974	16mm/ 20mm
(xix) Standard to which Insulator disc shall conform.		IS : 731-1971 As amended upto date	

16 ACSR PANTHER CONDUCTOR

1.0 SCOPE:

This section of the specification covers the technical specification for design manufacture, testing and supply of ACSR PANTHER (Aluminium conductor galvanized steel reinforced) conductor for use in high voltage transmission lines.

2.0 STANDARD:

The design manufacture, galvanizing and testing of ACSR conductor against this tender shall conform to the following Indian standard specification as amended up to-date:-

i) IS:390 (Part-II)- Specification for ACSR conductor for overhead Transmission purposes.
ii) IS:2633-1966- recommended practice for hot dip galvanizing of iron & steel.
iii) IS:2633-1972- Method for testing uniformity of coating on zinc coated articles.
iv) IS:4826-1979-Specification for hot dipped galvanizer coatings on round steel wires.
v) IS:6745-1972- Method for determination of Mass of Zinc Articles.
vi) IS:209-Specification or Zinc.
vii) IS:1778- Specification for Reels & Drums for Bare conductors.

3.0 TECHNICAL PARTICULARS:

The important technical requirements of ACSR conductor are as below-

SPECIFIC TECHNICAL PARTICULARS OF 'PANTHER' CONDUCTOR

1. CONDUCTOR DATA

(a)	Complete Conductor	
(i)	Code Name	"Panther "
(ii)	Size/ Stranding	30/3.00 mm Alum + 7/3.00 mm steel.
(iii)	ISS to which conductor shall conform to	IS. 398- Part_II
(iv)	Nominal copper area	130. sq.mm
(v)	Diameter of complete conductor	21.00 mm
(vi)	Nominal Aluminum Area	200.00 Sq. mm
(vii)	Sectional Area of Aluminium	212.10 Sq. mm
(viii)	Total sectional area	261.50 sq. mm
(ix)	Approximate total weight	974 Kg/KM
(x)	Ultimate tensile strength of conductor.	9127 KG
(xi)	Approx. calculated breaking load.	89.67 KN
(xii)	Calculated resistance at 20 degree(maxm).	0.1400 ohm/KM
(xiii)	Final module of Elasticity	80GN/meter
(xiv)	Co-efficient of liner expansion	17.7x10´6 Per. ºC
(xv)	Standard length in which conductor Will be supplied.	1.2 Kms ±5%(As per actual requirement of the site)
(xvi)	Lay Ratio	
	(a) Steel Core	Max-28 Min-13
(b)	Aluminium	
	12 wires	Max-16 Min-10
	13 Wires	Maxm-14 Minm-10

(B) **Strands**

WIRES		**Aluminium**	**Steel**
(i)	No. of strand	30	7
(ii)	Diameter(mm)		
	(a) Strandard	3.00	3.00
	(b) Maximum	3.03	3.06
	(c) Minimum	2.97	2.94
(iii)	Sectional area(mm^2)	7.069	7.069
(iv)	Weight (Kg/Km)	19.11	55
(V)	Resistance at 20 ºC when Corrected to standard wt.		
	(a) Standard (ohm/Km)	4.025	--
	(b) Maximum (ohm/Km)	4.107	--

vi)	Minimum ultimate tensile stress (Kg/mm²)		16.80	134.00
vii)	Minimum breaking load			
	(a)	Before stranding (KN)	1.11	9.29
	(b)	After standing (KN)	1.11	8.83

ZINC COATING:

a)	**No.** of one minute dip	--	3
b)	Minimum weight of zinc	--	26 g/m²
c)	Process of galvanising joint in strands	as per IS: 398 (Part-D)	Not per-mitted

2. REEL OR DRUM:

a)	**No. o**f standard length	One
b)	Dimension of reel of drum	As per requirement
c)	**Specification for drum**	IS:1778

3 MATERIAL AND WORKMANSHIP

a) The aluminum wires shall be hard drown form electrolytic aluminum rod having purity not less than 99.5% the end of the conductor shall be treated in approved manner to avoid ingress of moisture.

b) The steel wires shall be drown form high carbon steel wire rods produced either by the acid or the basic open hearth process or by the electric process. Steel produced by Bessemer process shall not be used for drawing wire and shall conform to the following requirements as regards to the chemical composition.

Element	Composition percentage
Carbon	0.50 to 0.85
Manganese	0.50. to 1.10
Phosphorus	Not more than 01.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

The steel wire shall be hot dip galvanized conforming to IS:2629-1966 (latest) and shall have weight of zinc coating as per IS:4126-1968 (latest). The quality of zinc for coating, of steel wire strands shall be Zn 98 of IS: 209 electrolytic high grade zinc of 99.95% purity.

4.0 MATERIAL AND WORKMANSHIP:

4.1 The material and workmanship will strictly conform to the requirement of IS:398 Part-II as amended up to date.

4.2 The individual wires as well as the stranded conductor shall be smooth as free from all imperfections as spills & splits. The steel wires shall be evenly and uniformly coated with zinc complying with IS:209.

5.0 TEST DURING MANUFACTURE:

5.1 The individual wires as well as the finished ACSR conductor during manufacture shall be tested in accordance with the stipulation made in IS:398 part-II as amended up to date.

5.2 Six copies of test reports for all Routine tests as carried out during manufacture of the conductor shall be furnished to the purchaser for approval immediately after the material is ready after manufacture and is offered for inspection.

5.3 The test reports shall clearly state the designated number of drums and length of conductor covered the test reports. The reports shall also clearly indicate the test reports . the reports shall also clearly indicate the specified values as per IS: 398 (part-II) of each parameter to facilitate checking of the test reports.

5.4 The purchaser may ask the suppliers to carry out even such tests which may not have been specifically laid down in the Indian which may not have been specifically laid down in the Indian standard specification but being done as normal practice and which in opinion of purchaser is necessary for ascertaining quality of material. All costs of tests carried out on above shall be born by the suppliers.

6.0 TYPE TESTS:

6.1 The tenderers are advised that they should submit copies of latest type test reports conducted either by CPRI, Bangalore or TAG Corporation, Madras for the conductor being procured under this tender. However, if considered necessary, the purchaser may also get the ACSR conductor tested for type test at C.P.R.I, Bangalore or at TAG Corporation, Madras before accepting the materials. In that event the supplier will have offer Random Sample of conductor immediately after placement of purchase order which shall be collected and sealed jointly by the representative of the purchaser and the supplier and shall be sent for carrying out type tests.

6.2 Following tests shall constitute type tests.

i) Surface condition test of ACSR conductor.

ii) Ultimate tensile strength test of ACSR conductor.

iii) D.C Resistance test.

iv) Corona /Radio interference voltage test, if applicable.

6.3 Once the sample is drawn in the entire responsibilities of getting the type test conducted and submission of report of the same will be of the supplier. However, if the supplier has submitted along with their offer reports against type tests carried out by CPRI, Bangalore or Tag Corporation, Madras and the report is considered satisfactory and acceptable by the purchaser, further carrying out of type test may be waived.

7.0 PACKING & MARKING:

The conductor shall be supplied in non-returnable strong drums with logging of non-perishable & treated wood conforming to IS: 1778 as amended up to date.

Such drum or reel, shall be marked with the following:-

i) Trade name, if any,
ii) Name of manufacturer.
iii) Contract/specification number.
iv) Name and address of the consignee.
v) Size & type of conductor.
vi) Total length of conductor in KM
vii) No. of conductor length on each drum.
viii) Net weight of the conductor.
ix) Gross weight of the conductor.
x) Weight of empty drum with protective lagging.
xi) Position of the conductor end and arrow marking for unwinding.
The drum shall also be marked with ISI certification marks

17 S.W.G. 7/9 EARTHWIRE

1.0 SCOPE:

This section of the specification covers the technical specification and general terms and condition, other supply terms for design, manufacture, testing and supply of galvanized steel stranded earth wire of 110 Kg/mm² quality for use in high voltage transmission line.

2.0 STANDARD:

The design, manufacture, galvanizing and testing of G.S.S. earth wire against this tender shall conform to the following Indian standard specifications as amended up to-date:-

i) IS:2141- 1968 Specification for galvanized stray strands.
ii) IS:2629-1966 Recommended practice for hot dip galvanizing of iron & steel.
iii) IS:2633- 1972 Methods for testing uniformity of coating of zinc coated articles.
iv) IS:4826-1979 Specification for hot dipped galvanized coatings on round steel wires.
v) IS:6745-1972 Method for determination of Mass of coating on zinc coated iron & steel Articles.
vi) IS:209-1979 Specification for zinc.
vii) IS:1778- Specification for Reels & drums.

3.0 TECHNICAL PARTICULARS:

The important technical requirements of 7/9 S.W.G, G.S.S Earth wire are as below-

SPECIFIC TECHNICAL REQUIREMENT OF G.S.S 7/9 EARTH WIRE

DETAILS OF PARTICULARS :

STRANDED EARTH WIRE :

1.Size of Earth wire	7/9 SWG Earth wire (110 Kg/mm2 quality).
2.ISS to which earth wire conform	IS: 2141-1968 (Up-to-date)
3.Overall diameter of earth wire (mm)	10.98
4.Total weight (Kg/Km)	583
5.Cross sectional area (mm2)	73.64
6.Minimum ultimate tensile strength (Kgf/mm2)	110
7.Minimum breaking load (kg)	8134
8.Co-efficient of linear expansion per ^{o}C (Calculated).	11.5x10-6
9.Calculated modulus of Elasticity (kg/Cm2)	1.933x10=6
10.D.C resistance at 20^{o}C (Ohm/Km)	3.00
11.Length of lay of stranded earth wire (mm).	
a) Maxim	172
b) Minimum	153
12.Standard length in which earth wire will be supplied.	2.3/2.4 KM / As per requirement

INDIVISUAL STRAND/WIRE

1) Number of wire	7
2)Diameter of each wire (mm)	3.66
3 Tolerance on diameter (mm)	$\pm$0.025
4 Standard sectional area (mm2)	10.51
5 Minimum elongation in100 mm length (mm)	5
6 Normal length without any joint or weld meter.	1500
7 Ultimate tensile strength (Kg/mm2)	110
8 Minimum Breaking load (Kg)	1163
9 Zinc Coating.	
a) No of one minute dip	3
b) Minimum weight of coating (gm/m2)	275
c) Quality of zinc Zn-99.99 as per	IS:209

10 Oiling Galvanised earthwire shall be dipped in boiled linsud oil

REEL/DRUM :

a) No. of standard length on one drum.	ONE
b) Weight and dimension of drum.	As per requirement.
c) ISS to which drum shall conform.	IS: 1778

4.0 MATERIALS AND WORKMANSHIP:

The material offered shall be of best quality and workmanship and strictly conform to the requirement of IS : 2141-1968 as amended up-to date.

4.1 The steel wires shall be drawn from steel made by open hearth basic oxygen or electric furnace process and of such quality that when drawn to the size of wires specified and coated with zinc, the finished strand and the properties and characteristics as specified in this specification. The wire shall not contain sulphur and phosphorus exceeding 0.065% each.

4.2 The outer wire of the G.S.S. wire shall have a right hand lay. The lag of the strands shall be of the length as specified in this specification. The wires shall be so stranded together that when an evenly distributed pull is applied at the end of the completed strand, each wire will take an equal share of the pull.

4.3 GALVANISATION:

All steel wires of the strand shall be hot dip galvanized in accordance with IS: 2629-1966 "Recommended practices for hot dip galvanizing of iron and steel " zinc to be used for this purpose shall be of grade Zn 99.99% as per IS 209-1979.

The coating of zinc on steel wires shall be treated as per IS: 2633-1972 and the weight of zinc coating shall be determined as per IS 6745-1972 **.** the weight of zinc coating shall be as per IS:4826-1979.

4.4 STANDARD LENGTH AND JOINTS ALLOWED:

The G.S.S. ground wire shall be supplied in the standard length.
The normal lengths of strand which shall be supplied without Joints or welds in the individual wires excluding welds made in the rod before drawing shall not be less than 1500 Meters. In case where joints in the same, wire shall be separated by a length not less than 1500 meters and further joints in different wires in a strand shall not be less than 20 meters apart.

4.5 FREEDOM FROM DEFECTS:

Each coil/reel G.S.S earth wire shall be warranted to contain no weld joint or splice other than in the rod before it is drawn and those permitted. The wire shall be circular and shall be free from scale, irregularities, imperfections, flaws splits and other defects. The zinc coating shall be smooth, even and bright.

5.0 TEST DURING MANUFACTURE AND TEST REPORTS:

The individual steel wires as well as the finished G.S.S. earth wire during the manufacture shall be tested in accordance with stipulations made in IS:2141-2968 as amended up-to-date.

Six copies of test reports for all routine tests as carried out during manufacture of the earth wire shall be furnished to the purchaser for approval immediately after the material is ready after manufacture and is offered for inspection.

The test reports shall clearly state the designed number of drums and size & length of wire covered under the test revalues as per, IS :2141 of such parameter to facilitate checking of the test reports.

The purchaser may ask the suppliers to carry out even such tests which may not have been specifically laid down in the Indian standard specification but being done as a normal practice and which in opinion of purchaser is necessary for ascertaining quality of material. All costs of test carried out as above shall be borne by the suppliers.

6.0 PACKING & MARKING:

The G.S.S. Earth wire shall be supplied in non-returnable adequately strong drums with logging of non-perishable & treated wood conforming to IS: 1778 as amended up to date.

Each drum or reel shall be marked with the following:-

i) Trade name, if any.
Ii)Name of manufacturer.
iii) Contract/specification number.
iv) Name and address of the consignee.
(v) Size & type of Earth wire.
(vi) Total length of Earth wire in km.
vii) No. of Earth wire length on each drum.
viii) Net weight of the earth wire.
ix) Gross weight of the drum & earth wire.
x) Weight of empty drum with protective lagging.
xi) Position of the Earth wire and Arrow marking for unwinding.
xii) Drum & lot number.

The drum shall also be marked with IS certification mark. The reels shall be of such construction as to ensure delivery of Earth wire in the field free from displacement an damage and shall be capable to with stand all stress due to handling & stringing operations. The Earth wire surface shall not get dented scratched or damaged in any way during handing transportation & erection. The supplier shall be responsible for all damage due to improper and inadequate packing.

The Earth wire shall be properly lagged on the drums and method of lagging to be employed shall be clearly stated in the tender. It shall not notched to suit the reel but held in place by steel strapping.

18 132 KV TRANSMISSION LINE TOWERS AND GALVANIZED STRUCTURE

A. GENERAL

i) Line 132 KV D/C Transmission line

B).TOWER

i) Design span 328M

ii) Configuration Vertical Configuration

iii) Type of Tower

A2 Type - 0º to 2º

B2 Type - 2º to -30º

C2 Type - 30º to -60º

MT2 +21.5 M Type- Special Towers.

iv) Design weight of Tower in Kg

a) STUB:

Sl. No.	Type of Tower	Structures		Fasteners with Accessories	Total
		Section of size 110x110x10 mm and below	Section above 110x110x10 mm size		
1.	A2 type Dry Wet	 150.56 159.68	 -	 2.39 2.39	 152.95 162.07
2.	B2 Type Dry Wet	 9.12 9.12	 351.84 472.68	 2.55 2.55	 363.51 484.35
3.	C2 type Dry Wet	 12.16 12.16	 604.32 827.56	 2.55 2.55	 619.03 842.27
4.	MT2 +21.M Type	13.12	335.16	2.55	350.83

b) Template:

Sl. No.	Type of Tower	Structures		Fasteners with Accessories	Total
		Section of size 110x110x10 mm and below	Section above 110x110x10 mm size		
1.	A2 type	448.10	-	11.35	459.45
2.	B2 Type	775.80	-	20.03	795.83
3.	C2 Type	928.5	-	23.21	951.73
4.	MT2 +21.5 M Type	1232.16	-	23.32	1255.48

c) Super Structure:

Sl. No.	Type of Tower	Structures		Fasteners with Accessories	Total
		Section of size 110x110x10 mm and below	Section above 110x110x10 mm size		
1.	A2 type	2989.65	30.56	198.87	3219.08
2.	B2 Type	3407.12	1221.54	217.84	4846.50

3.	C2 Type	4341.68	1889.32	234.81	6465.81
4.	MT2 +21.5 M Type	5116.96	1400.00	273.78	6790.74

d) 3 Mtr : Extension :

Sl. No.	Type of tower	Structures		Fasteners with Accessories	Total
		Section of size 110x110x10 mm and below	Section above 110x110x10 mm size		
1.	A3 + 3M	602.16	10.08	21.59	633.83
2.	B2 + 3M	643.54	247.66	32.55	923.75
3.	C2 + 3M	951.59	408.99	40.86	1401.44

e) 6 Mtr : Extension :

Sl. No.	Type of tower	Structures		Fasteners with Accessories	Total
		Section of size 110x110x10 mm and below	Section above 110x110x10 mm size		
1.	A2 + 6M	1154.80	15.32	42.01	1212.13
2.	B2 + 6M	1127.72	490.36	49.78	1667.86
3.	C2 + 6M	1445.57	749.60	61.73	2256.90

f) 21.5 M Extension :

Sl. No.	Type of tower	Structures		Fasteners with Accessories	Total
		Section of size 110x110x10 mm and below	Section above 110x110x10 mm size		
1.	MT2 + 21.5M	8707.78	2159.54	340.75	11208.07

The detailed design, bill of material and the shop drawings etc of towers/stubs/extentions shall be procured by the contractor directly from BSEB

C. FOUNDATION

(1) DESIGN, EXCAVATION VALUE IN CUBIC METER

	DRY	WET
A2 type	13.540	41.68
B2 type	34.70	120.50
C2 type	56.32	166.08

(2) DESIGN CONCRETE VOLUME IN CUBIC METER

	DRY	WET
A2 type	2.195	5.237
B2 type	5.016	13.204
C2 type	7.903	21.056

D. CONDUCTOR

(1) Conductor size	-	30/3.00 mm AL + 7/3.00 mm steel ACSR panther conductor.
(2) UTS of conductor	-	9126 kg
(3) Weight of conductor	-	976 kg/km
(4) Over all diameter	-	21 mm

E. EARTH WIRE

(1)	Earth wire	-	7/9 SWG.
(2)	Size	-	3.66 mm.
(3)	U.T.S. of Earth wire	-	110 kg/mm2
(4)	Weight	-	583 kg/km
(5)	Over all diameter	-	10.98 mm.

F. SCHDULE OF TOWER /TOWER ACCESSORIES

(1) SCHEDULE OF TOWER

A2 Type.....
B2 Type..... As per design requirement
C2 Type.....

(2) TOWER ACCESSORIES

Number Plate

Danger Plate As per design requirement

Phase Plate

Anti Climbing Devices

Pipe Type Earthing Set

Hanger (20 mm dia Rod)

U-Bolt (16 mm dia)(With 4 Nos. Nuts and 2 Nos. Spring Washer)

19 HARDWARE FITTINGS FOR PANTHER CONDUCTOR.

1.0 SCOPE

This section of the specification covers technical specification and other terms and conditions for design, manufacture, testing and supply of conductor/Earth wire accessories and hardware fittings as per details in specification.

2.0 S T A N D A R D :

Design, Manufacture, Galvanizing and Testing of conductor/Eartwire Accessories and hardware fittings shall conform to the following Indian Standard Specification as amended up to date.

1) IS: 2121- Specification for fittings for Aluminum and steel cord Aluminum conductors.

2) IS: 2486 Specification for insulator fittings for over-head power lines.

3) IS: 209 SPECIIFICATION FOR Zinc.

4) IS: 2629 Recommended practice for hot dip galvanizing for Iron & Steel.

5) IS: 2633 Method for testing uniformity of zinc coating on hot dip zinc coated articles.

6) IS: 9708- Specification for vibration dampers.

7) IS:-2141- (Part-II Mid span compression joint.

8) IS:2141- (Part-II) Specification for vibration damper.

3.0 TECHNICAL PARTICULARS:

A GENERAL REQUIREMENTS:

Material offered shall be of best quality and workmanship. All casting shall be free from blow-holes, flaws, cracks or other defects and shall be smooth, close grained and of true forms and dimensions. All machined surfaces shall be true, smooth and well finished. Metal fittings or drop forged steel or heat treated malleable cast iron for insulator string hardware shall have excellent mechanical and electrical properties, such as strength, toughness and high corrosion resistance and free from corona formation. The material employed in the manufacture of accessories, viz aluminum, aluminum alloys, malleable iron, forged steel and stainless steel depending on the types of application, shall be corrosion resistant and machinable.

Fittings and accessories shall be supplied complete in all respect, suitable for the proposed attachment and for the size of concoctor and Earth wire for which they are to be used.

All bolts, nuts, screw heads shall be of the whit worth standard thread. Bolt heads and nuts shall be hexagonal. If required the nuts shall be locked in an approved manner. The threads in nuts and tapped holes shall be cut out after galvanizing and shall be well lubricated/greased. All other threads shall be cut out before galvanizing. The bolt threads shall be under cut to take cre increase in diameter due to galvanizing. Washers shall be electro galvanized.

The general design of hardware shall be such as to ensure uniformity, high strength, free from corona formation.

All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching insulators to the towers or to the line conductors shall be so designed as to reduce to the minimum the damage to conductors, insulators or the fittings arising from the conductors vibrations.

Adequate bearing area between fittings shall be provided and point or line contact shall not be there.

All fittings shall be resistant to atmospheric corrosion and shall be suitably protected against corrosion both in storage and service.

The accessories shall be such as to avoid local corona formation or discharge likely to cause interference to either sound or vision transmission. Visible corona voltage of conductor accessories shall be greater than 11% or maximum line to neutral voltage of the line.

B CONDUCTOR FITTING:

I) Compression type Mid span Joints.

Compression type mid span straight joints offered shall conform to technical particulars.

II) REPAIR SLEEVS:

Compression type repair sleeves shall be made of extruded aluminum and shall be suitable to provide reinforcement for conductor with broken or damage aluminum strands. The repair sleeves shall be designed to make good conductor of which not more than 1/6 of the strands in the outer most layer are damaged /severed. The repair sleeves after compression should present smooth surface. The repair sleeves shall be so designed that conductivity of the joint shall not be less that 100% of that of conductor. Other details will be as per drawings and of technical particulars.

III) PREFORMED ARMOUR RODS:

Helically twisted formed armour rods offered shall be suitable for ACSR. Panther conductors to provide rigidity and protection to the conductor at all the suspension points due to vibrations.

Armour rods shall be made of 99.6% pure electrolytic Aluminium or Aluminium alloy depending on the type of construction. The armour rods shall be marked in the centre suitable to indicate the commencement point of applying armour rods in base rods before drawing. The armour rods shall be capable of being fixed by hand on the conductor without the aid of any tools or plants implements. The direction of spiral shall be the same as that of the conductor. The wires of the outer most layer of aluminum strands of the conductor shall have right hand lay. The loading stress of armour rods on the conductor shall be evenly distributed over the entire length and there shall be tendency of loosening at the ends. Performed armour rods shall not loose their resilience even after two or three applications. The rods should be capable of providing high self retaining strength and protection against vibration damage and fatigue failure of conductor. The ends should be properly ball ended. So that the danger of corona formation is avoided.

The surface of the armour when filled on the conductor shall be smooth and free from protection cuts and abrasions etc. dimensional sketch of the armour rod is enclosed with this specification.

C) STOCK BRIDGE VIBRATION DAMPERS:

Calculations and complete details of design, weight etc of the damper shall be furnished with the tender together with the damping characteristics and energy dissipation curves of

the dampers and guaranteed of their effectiveness for the specified conductor. The offer is liable to be rejected in absence of the above details.

The vibration damper shall be of standard design. The clamp of the vibration damper shall be made of aluminum alloy, so designed as to prevent any damage to or chaffing of the conductor during erection or continued operation if there is any chance of the clamp chaffing, the conductor while in service suitable aluminum liners shall be provided. The messenger cable shall be made of high tensile strength steel strands and preformed in order to prevent subsequent drop of weights in service. The damper weight made of cast iron shall be attached to messenger cable by approved methods, clamping bolt shall be provided with self locking nuts.
All ferrous parts including the messenger cable, shall be hot dip galvanized. The ends of the messenger cable shall be effectively sealed to prevent corrosion. The vibration damper and its attachments shall have smooth surface, to ration damper shall be so designed that in case of loosening of the bolt or changing free part of the clamp it does not allow damper to disengage from the conductor.

D) INSULATOR HARDARE FITTINGS:

The insulator hardware fittings for suspension and tension towers shall generally constitute of following components:-

i) Anchor shackle for ball hook for attachment of the suspension strings to tower hanger and tension strings to tower strain plates.

ii) Suitable yoke assembly for double suspension and double tension fittings.
iii) Suitable arcing horns and fittings.
iv) Suspension/tension clamps.
v) Sag adjustment plates for dead end assembly.
vi) Other fittings i.e eye links, chain link, ball clevises, socket clevis, eye clavic, clevices etc.
vii) Bolts and nuts, watchers split pins etc.

(E) CLAMPS

i) SUSPENSION CLMPS

Suspension clamps offered shall be made of high strength aluminium alloy suitable for use with conductor with armour rod. The design shall be such as to avoid hot spot, Kicks cuts, grooves projectors etc. which are likely to damage conductor or lead to localized pressure, clamps shall have satisfactory corona performance, no sharp radius or curvatures, ridge and excrescence etc. cotter pins cotter bolts U,bolts , nuts washers etc. shall be made of galvanized steel. Split pins of suitable size and strength shall be made of brass. The clamps shall permit the conductor to slip before failure of the conductor and shall have sufficient slipping strength to resist conductor tension under broken wire conditions. It shall have sufficient contact surface to minimize damage due to fault current.

ii) TENSION CLAMPS:

Tension clamps shall be made of aluminium alloy and shall be of proper type. The clamps shall not permit, slip of any damage to or failure of the conductor at a load of less than 95% of the ultimate strength of conductor. Mechanical efficiency of the clamp shall not be affected by method of erection involved. Come along or similar clamp during stringing operations.

iii) ARCING HORN:

The Insulator hardware assemble shall have provision for fixing a set of arcing horns on the Insulator hardware fittings.

4.0 DRAWINGS:

The tenderer shall submit fully dimensioned drawings to scale indicating the materials of each part for dimension all under supply. The complete string drawing, both suspension and tension, shall indicate the over all length with its variations when subjected to tension as also the spark over distance. The following arrangement of complete insulator strings and their component parts shall be clearly indicated.

i) Attachment of the tower hanger of strain plate.
ii) Arcing Horn attachments.
iii) Suitable ball and socket type fittings for interconnecting insulator units to the top and bottom clamps.
iv) Detailed drawings of suspension and tension clamps indicating design adopted for preventing damage to the conductor & earth wire.

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5.0 GALVANISING:

All ferrous metal parts except those made of stainless steel shall be galvanized in accordance with latest issue of IS: 2633.The zinc used for galvanization shall conform to grade Zn-98 as per latest issue of IS:209, Spring washers, where used, shall be electro galvanized.

6.0 INTER CHANGEABILITY:

All hardware fitting and conductor accessories shall be of standard design and made to gauge or jig and shall be interchangeable in all respects with similar items.

7.0 TESTS/REPORTS:

Conductor accessories and hardware fittings will be subjected to all tests as per relevant Indian standard specification specified in Para 2.30 . The tests will be categorized in three grades, normally (i) Type ,(ii) Acceptance Tests and (iii) Routine Tests.

7.1 TYPE TESTS:

Type tests are normally carried out once and is not required to be carried out against all orders. Tenderers are therefore, to submit along with their offer reports in respect of type tests carried out as per provision of Indian standard specification by a reputed / recognized testing laboratory.

7.2 ACCEPATANCE TESTS:

These are such tests which are carried out for acceptance of material. This will constitute all tests as prescribed in the relevant Indian standard specification.

7.3 ROUTINE TESTS:

These are such tests which will apply to all fittings.

Reports in respect of all tests carried out during manufacture as per Indian standard specification will be submitted to department for approval at the time material is offered for inspection.

Tenderers shall clearly state in their tender about testing facilities available in the laboratories at their works to confirm their ability to carry out all tests as per Indian standard specification.

Costs in carrying out any/all tests as above will be borne by the tenderer and will be included in their quoted price.

8.0 SPECIFIC TECHNICAL REQUIREMENTS FOR HARDWARE FITTINGS

1 Technical particulars of ACSR Conductor for which accessories and hardware fittings are required.

(a) ACSR Conductor.

ACSR Panther Conductor of composition 30/3.00 mm Al. + 7/3. 00 mm St. conforming in all respect to IS. 398 partII

(b) EARTHWIRE.

7/9 SWG GSS Earthwire conforming in all respect to IS:2141.

2 Conductor Accessories and hardware fittings for ACSR Panther conductor (for use in 132 KV D/C Line).

(a) M.S. COMP. JOINT.

(i) Physical Dimension	suitable ACSR Panther conductor
(ii) Material specification	as per ISS
(iii) Minimum Falling Strength	100% of UTS of ACSR Panther Conductor.
(iv) Slipping strength	95% of UTS of Conductor measured.
(v) Electrical Resistance expressed as percentage of measured resistance of equivalent length of conductor.	75%

(b) <u>REPAIR SLEEVE:</u>

(i) Physical Dimension	suitable to ACSR Panther conductor.
(ii) Material specification	as per ISS
(iii) Minimum Failing strength	95% of UTS os ACSR Panther.
(iv) Electrical Resistance expressed as percentage of measured length of conductor.	75%

(c) **VIBRATION DAMPER**

(i) Physical Dimesion	Suitable to ACSR Panther conductor
(ii) Material-(a) Clamp	Alminium alloy
(b) Messenger cables	High strength Steel wire
c) Weight	Cast Iron
iii) Galvaniastion	
a) Spring washers etc.	Electro galvanised.
b) Other ferrous parts	Hot dip galvanised.
iv) SLIP STRENGTH OF DAMPER CLAMP.	
a) Before fatigue test	Not less than 250 Kg
b) After fatigue test	Not less than 200 Kg
v) Maximum permissible dynamic strain on conductor with damper.	150 Micro strain.
vi) Minimum no. of cycles for fatigue performance.	Ten million
vii) Amplitude for fatigue	$\pm$ 1 MM at the highest resonance frequency.
viii) With velocity range for effectiveness of the damper.	Upto to30 KV
ix) Claimpul torque	Approx x 6 kg meter
x) Normal span	350 Mtrs

d) **PREFORMED ARMOUR ROD**

i) Physical dimension	Suitable to ACSR Panther conductor
iii) Material	99.6% pure electrolytic A1 or A1. alloy.
iv) Tensile strength	50,000 PSI
v) Conductivity	39% of inter national annealed copper strands.

20 FASTERNERS AND ACCESSORIES TOWER MEMBERS

1.0 SCOPE

The scope of supply under this specification covers following items for 132 KV D/C transmission line towers.

i) Tower Members, Tower Accessories i.e. danger plate, number plate, phase plate etc.
ii) Galvanized hangers with blots and nuts for suspension towers.
iii) Galvanized U-Bolts with bolts and nuts for tension towers.
iv) Anti climbing device.
v) Pipe type earthing set.
vi) Bolts, Nuts & washers, step blots etc.

2.0 STANDARDS:

The tower members, fasteners and tower accessories shall be fabricated, galvanized and tested in conformity with the following Indian Standard Specification as amended up to date:

i) IS: 226
OR
IS:2062 - Specification of structural steel to be used in fabrication of towers.
ii) IS:802- code of practice for use of structural steel in over head transmission
iii) IS:2427- Specification for bolts. for tower connection
iv) IS:1023H Specification for step bolts
v) IS:1363- specification for hexagonal nuts(Part-III)
vi) IS:2016- specification FOR plain washers.
vii) IS:6610- Specification for heavy washers.
viii)IS:3063- Specification for spring washers.
ix) IS:1367 Mechanical properties and testing(Part-III) methods for Bolts, screws and stubs.
x) IS:1367 Mechanical properties and test methods (Part VI) for nuts.
xi) IS:4759- Specification for Galvanizing of structural members of towers and plain & heavy washers.
xii) IS:1397 Specification for Galvanizing threaded fasterns(Part-13).
xiii) IS:200/209- specification for Zinc
xiv) IS:2033 - Methods for testing uniformity of coating over zinc coated articles.

3.0 MATERIALS:

Tower members including cross arms shall be fabricated of structural steel section conforming to IS: 2260 OR IS:2062. The towers shall be fully galvanized except for the portion of the stub to be encased inn the concrete foundations, which shall be supplied black.

3.1 ANTI CLIMBIG DEVICES:

Anti climbing device of barbed wire to be fitted on tower at a suitable height having three circles of worse in the form of an umbrella on the outside of the tower and similar number on the inside of the tower as per drawing will be supplied. Ant climbing devices will be supplied with all required Bolts, nuts and washers**.**

3.2 WEIGHTS:

The design weights of each type of tower, stub and extension are detailed in the specification. The weight of tower/accessory means the weights of all still structural members indicated in the approved fabrication drawings and bill of materials, without taking into consideration the reduction in weight due to drilling of bolts, holes, chamfering et. of the increase in weight of special fittings, Bolts, nuts and washers hangers etc. There shall be no increase in weight on account of galvanization**.**

3.3 EARTHING OF TOWERS:

Each tower shall be provided for earthing with the galvanized iron pipes of 25mm dia buried in the ground. Suitable arrangement to connect the earthing pipe to one of the tower leg of the cover shall be make. These pipes shall be connected to the tower leg by means of the galvanized straps(6mm x 10 mm). Two oles of 18 mm dia, 50mm apart

shall drilled on one of the tower legs of the towers at about 150 mm above the ground level, for connection of these flats. The including lugs etc. Drawings for tower earthing arrangement shall be as approved by BSEB**.**

3.4 FASTENERS:

Bolts and nuts will be supplied of GKW/approved ISI marked make and will conform to IS:12427, washers will be supplied of Forbes and Forbes/ standard make and will conform to IS;1573

3.5 STEPBOLT:

Each tower shall be provided with galvanizes step bolts on one of the leg members. The dia and length of step bolts shall not be less than 16mm & 150mm respectively. The blots shall be spaced about 450 mm apart and shall extend form a distance of 2500 mm above the ground level to the top of the tower. Each step bolts shall be provided with two nuts on one end to fasten the bolt securely with the leg members and a button head at the other end to prevent the foot from slipping. The step bolts shall be capable to withstand a vertical load of not less than 150 kg.

3.6 HANGERS AND U-BOLTS:

Galvanised hangers & U-Bolts with associated nuts will be supplied as per drawing enclosed.

a) Hanger: Hanger should be of 975 mm length and weighing 2.28 Kg. of 20 mm dia rod.
b) U-Bolt: U bolt with four nos. of nut and two nos. of spring washer should be of size 16 mm dia weighing 0.68 Kg.

3.7 DANGER, NUMBER AND PHASE PLATES.:

Number plates, danger plates and phase plates shall be made of mild steel plate 2mm thick and vitreous emceed back and front. The letters, figures and the conventional skull and bone on danger plates shall be in single red on the front side. Number plates shall be inscribed with number of the tower location preceded by the letters defining the type of the tower. Phase plates shall be colored red, yellow, and blue to indicate the phase of the conductor. The letters on number plates shall be in red on white back ground. Danger/Number/phase plate will be supplied with galvanized bolts, nuts & washers. Drawings for danger, number and phase plates shall be as approved by BSBE**.**

4.0 DRAWING

The structural drawing for each tower and all other required drawings e.g. foundation drawings, sag tension charts tower spotting data etc shall be procured by contractor from BSEB directly which will be facilitated by the purchaser. Tower fabricator will develop shop fabrication drawing for fabrication of tower members. The approx wt. of each type of tower has been furnished**.**

5.0 FABRICATION AND WORKMANSHIP:

Fabrication of tower members shall be done in accordance with Indian Standard Specification.

5.1 DRILLING & PUNCHING:

All steel sections before any cutting work is started shall be carefully straightened and true by pressure and not by hammering. They shall again be trued up after being punched and drilled. No rough edges fresh form shears shall be left. All sheared and cut ends shall be flamed off.

Holes for bolts shall be drilled or punched by Jig. But drilled holes shall be preferred. All holes in sections over 12 mm must be drilled

Punched holes must be square with the plates and the wall of the hole parallel subject to following tolerance.

i) Holes must be perfectly circular. No tolerance.

ii) The maximum allowable difference in diameter of the holes on the two sides of section-0.8 mm(1/32").

iii) Holes must be square with sections and slant holes will not be permitted. All burrs left by drill or punch shall be removed completely.

5.2 GALVANISING

All member of the tower & accessories shall be galvanized as per relevant ISS after all fabrication work is complete except that the nuts may be tapped or return after galvanizing. Threads of bolts and nuts shall be so made that after galvanizing the nuts shall have nest fir and can be tuned with finer throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolt. Spring washer shall be electo-galvanised**.**

6.0 TEST DURING MANUFACTURE:

All tower members accessories/fatteners during fabrication galvanization will be tested as per ISS and those mentioned in this specification. Six copies of such test reports shall be submitted to the purchaser for approval immediately the materials are ready after manufacture. One copy of approved test report should be enclosed with dispatch documents. Purchaser may ask the supplier to carry out any such test/tests which are not specifically mentioned in ISS but considered necessary in the opinion of purchaser for ascertaining the quality of material.

7.0 ERECTION MARK:

Such individual tower member shall carry a code number confirming to the component number given to it in the fabrication drawing. The code number of approved size shall be stamped with a metal die on the member before galvanization and shall be legible after galvanizing. The letters denoting the different types of towers shall precede the code number. The Board's emblem BSEB shall be stamped at two ends of each tower member so as to be legible after galvanizing**.**

8.0 PACKING :

The material shall be boxed or bundled for transport in the following manner:

Angles shall be packed in bundles securely wrapped four time around at each and every foot with No. 9 SWG gauge wire with ends twisted tightly. Gross weight of any bundle shall not exceed 460 Kg. and the length of any individual member 6000mm.

Cleats, angles, brackets, fillets, plates and similar loose pieces shall be bolted together in multiples, and securely wire together thorough holes, wrapped round at least four times with no. 9 SWG gauge steel wire and ends twisted tightly. Gross weight of each bundle shall not exceed 70 Kg**.**

9.0 MARKING OF PACKING

Each bundle or package shall have the following marks:

a) The name/designation of the consignee.

b) Ultimate destination

c)The relevant marks and number of tower members or reference number of blots, nuts & other small part like gussets plates various attachment etc.. The marking shall be stenciled indelible ink on the top member in the bundles of tower and on wooden boxes or gunny bags containing smaller components.

10.0 REPLACEMENT/REJECTION OF DEFECTIVE MATERIAL.

If during the process of manufacture/supply, the purchaser decides and notify to supplier in writing that they have manufactured/supplied any material of inferior quality or deviating form specification/drawings, the same shall have to be immediately replaced by the supplier by good quality material at supplier's risk and cost. In case supplier fails to replace the defective materials within a reasonable period, the purchaser may on giving seven days notice to the suppliers, reject the entire material and get the material arranged form alternative sources at the risk and expense of the supplier**.**

11.0 QUANTITIES:

The quantity of tower members/accessories/fasteners will be as per design requirement. The supplier will however, supply the exact quantity as per actual requirement.

21 ERECTION OF TRANSMISSION LINE

1.0 SCOPE :

The scope of work under this specification covers construction of foundation, erection of all line, complete stringing of transmission line. The technical requirements under various items of erection work have been detailed below. These details are for the purpose of guidance only. However all such works even though not specifically mentioned but forming essential part of the work, will be deemed to be covered in the

scope of work of the contractor. Wherever any details not mentioned herein,the same shall be followed as per latest practice adopted by BSEB. The foundation drawings shall be procured by the contractor directly from the BSEB however he will be facilitated by the purchaser in this regard.

2.0 DETAIL OF WORKS:

(A)

i) DETAIL SURVEY:

Detail survey shall be conducted by the contractor immediately after receipt of the work order and survey reports should be furnished for approval.

ii) CHECK SURVEY:

Route profile/drawings indicating the alignment of the line along the route of the line shall be prepared by the contractor on the basis of details survey conducted immediately after award approved of this work order. These line drawings will indicate each and every tower locations, angle of deviation, as well as details such as villages, rail tracks, roads, rivers, nallahs etc. along the route of the line. The contractor will carry out check survey along this entire route of the line and submit to department for approval of complete final route profile, schedule of requirement of line material etc.

The contractor will make no alteration in the route profile of the line as fixed by purchaser as per details survey. In case any alteration is suggested. The contractor shall submit to department complete details and obtain approval in writing before carrying out any change.

(B) EXCAVATION FOR SITES ETC.

The scope of work will cover (i) excavation for tower site (ii) Excavation for tower footing and (iii) Back filling..

(i) EXCAVATION FOR SITE ETC.

The item excavation for tower site will include all required excavation for leveling around individual tower footings and for drawings and other required purpose. The surface of excavation for tower site shall be made to the full dimension required and shall be finished to the prescribed lines and graded Excavation materials shall be used for grading around the tower site from which the material were excavated.

(ii) EXCAVATION FOR TOWER FOOTINGS

Excavation for tower footings shall cover required excavation for construction of tower footings as per approved design drawing for each type of foundation which will include 150 mm clearance on all sides from the foundation pad. Any excavation done beyond this specified line shall be at the expense of the contractor. All excavated materials shall be kept at side, protected and maintained clean so as to be used to back fill and embankment at the tower site from which it was excavated and excess material shall be spread evenly around the site. All such locations where excavation is done on firm excavable land, the top soil shall be stacked separately and replaced after the construction work is competed.

For excavation work soil will be classified as follows:-

(a) Normal soil (Dry/Wet): Soil removable by means of ordinary spade shove, etc. Normal soil may be either dry or wet.

(b) Hard Rock: Soil which is excavated by crow bars. pixcces. etc. Hard Gravel/soil with singles mild stone etc.

(c) Soft Rock: Rock removable by chisel/hammering but not needing blasting.
(d) Hard Rock: Rock which require blasting by use of explosive drilling or use of pneumatic tools.

Note:- Where soil in a particular foundation of composite nature classification will be according to the type of soil which is preponderant in the footings. The decision of department regarding classification of soil will be final and binding in the contractor.

Where hard rock is encountered. holes for tower footings shall preferably be drilling. However, when blasting is resorted to as an economic measure. it shall be done with utmost care to minimize use of concrete for filling up the blasted area.

(iii) BACK FILLING :-

The excavated soil shall be kept a side and stacked near the foundation and after stubs have been set and concreting done, the same shall be used as back filling. Backfill shall comprises of earth only and shall be free from any vegetation or weed or stone/ boulders digged out during excavation. in cases where excavated material is not suitable for use as back fill, the contractor will procure additional back fill material from borrowed earth.

Backfilling shall be compacted around tower footing in horizontal layers having a thickness of not more them 240 mm after compacting which will be free from pockets. steals of other imperfections. Backfill will have optimum and uniform moisture content for the purpose of good compaction. If necessary, spraying of water may be done for achieving required moisture in the backfill.

(C) GRAVEL SUBBASE:

Gravel sub base shall be put under the concrete footing of some foundations as desired by the department, Gravel sub base shall be put just prior to placing of the concrete. The contractor will perform all excavation below the elevation of the underside of concrete cap required to place the gravel sub base. Gravel sub base shall consist of pit run free draining gravelly material containing no stones larger than 63.5 mm in size. The gravelly material shall be clean and free from vegetation piece of timber or other foreign material the top surfaces of complete sub base shall conform to the established elevation of the underside of the concrete cap. The normal maximum thickness of the gravel sub base of the tower footing will be 150 mm.

(D)TOWER EARTHING.

One feet of each tower shall be earthed by means of 1" galvanized iron pipe. 3 meters along, driven in ground near the tower and electrically connected to tower leg by means of 50x5 mm galvanized steel flat and galvanized bolts and Nuts the contractor shall check the resistance of earth at all locations after Erection and before the earth wire is connected. If the tower footing resistance is more than 10 ohm, the tower shall be further grounded by means of additional. One or more I "dia galvanized. pipe till earth resistance means less than 10 ohms is achieved. where tower stands on rock, effort shall be made to obtain a good ground by carrying a length of the galvanized steel tape from the tower leg to pipe driven in damp soil at a short distance from the tower base as possible. The connecting tape shall be buried in a groove cut in the rock surface and adequately protected from damage.

(E) SETTING OF STUBS

Stub angles shall be handled with care to avoid bending/damage. Stubs shall be set correctly in accordance with approved method. the stub angle shall be held Rigid by means of a rigid frames/stub setting templates in such a manner to prevent displacement during concreting. The basic responsibility for correct setting of stubs will be With the erection contractor. The difference in elevation between identical parts of any two stubs angles shall not exceed 1: 1000 of horizontal distance between the stubs.

The actual elevation of any stub angle shall not differ from the computed Elevation by more than 0.61 mm, The stud angles shall be located Horizontally so that each 'n' within 0.61 mm of it correct position, and The batter of the stub.

(F) CONCRETING:

Concreting of foundation shall be done as early as possible after excavation is complete including

All materials a cement sand broken stones etc MS Rod and biding wires required for concrete will be supplied by contractors at his cost. Concrete for foundation shall consist of one parts cement, two parts sand four parts of broken stone by volume.

(i)CEMENT

Cement used for concrete shall conform to latest IS for Ordinary Portland cement or other approved composition obtained from an approved maker. where the nature of ground is such that Portland cement concrete is likely to be chemically affected. High aluminum cement may be used. Cement consumption will be determined at the rate of 28 kg/cubic meter of concrete for 1:2:4 mix including wastage. The contractor shall take the prior approval of the purchaser for brand and grade of the cement to be used and strictly adaher to the same brand and quality..

(ii) SAND

The sand used for concrete shall be composed of hard silicones materials. it shall be coarse sharp, clean and free from dust. salt, vegetanle matter, alkali mice and other deleterious substance, it shall be screen through a mesh not more than 4.75 mm square in the clear, Fine sand of uniform grain size shall not be used. The contractor shall take prior approval of the quality of sand by producing a sample of it to the purchaser.

(iii) GRAVEL OR BROKEN STONE.

Gravel or broken stone shall be cleaned and free from injurious amounts of soft. friable, thin elongated or laminated pieces, alkali, organic matter or other deleterious substances. All gravel and broken stones shall be of approved grading. The aggregate will be 40 (1") maximum for the pyramid portion and 20mm (3/4") maximum for the chimney. The contractor shall take prior approval of the quality of gravel by producing a sample to the purchaser.

(iv) WATER

The water used in concrete shall be fresh, clean and free from any vegetable or organic matter, alkali and other impurities either in suspension or in solution and be quality fit for drinking purposes. saline water shall not be used.

(V) BATCHING

No batching equipment is foreseen for measuring the ration of the concrete ingredients and, therefore, may not be applicable.

VI) MIXING.

The concrete ingredients shall be mixed in a concrete mixer for not less than 1.5 minutes with all the ingredients to absorb full amount of water. Department will have the right to increase mixing time if the charging, and mixing operations fail to produce a concrete batch. Consistency of which is uniform. The concrete as discharged from the mixer shall be uniform in composition except where changes in composition or consistency are required. Excessive over mixing requiring addition of water, to preserve the required concrete consistency will not be permitted. Truck mixers may be permitted only if the mixers its operation is such that the concrete through out the mixed batch and from batch to batch is of uniform consistency and grading. Any concrete retained in truck mixers so long as to require additional water to permit satisfactory placing shall be wasted. Each mixer shall be subject to the approval of the engineer. The concrete will be normally mixed with diesel engine operated mixers as per standard practice. Hand mixing may be allowed only when mixer fails during concreting or when it becomes impossible to take the concrete mixer at site due to site conditions.

(VII) FORMS.

The contractor shall use form boxes of proper strength where necessary to confine the concrete and shape of the required line. will not be required where nature of material is such that it can be trimmed to the prescribed lines and will stand without caving or sloughing until the concrete has been placed. Before placement of concrete, precaution shall be taken to see that forms are in proper alignment and adequately secured, and shall be kept in accurate alignment. until the concrete has hardened. Before concrete is placed. surface of the forms shall be oiled with commercial form of oil to prevent sticking but will not stain the concrete surface. Forms shall be left in place for 24 hours and shall then be removed with care so as to avoid injury to the concrete.

VIII) PROCESS OF CONCRETING.

Concreting shall commence only after all proceeding works are completed inspected and got approved by purchaser.All surface of foundation upon or against which concrete is to be placed shall be from static water and debris. The surface of absorptive foundation against which concrete is to be placed shall be maintained thoroughly dry so that moisture will not be drawn from the freshly placed concrete. Construction joints shall be cleaned thoroughly of loose or defective surface. Concrete casting sand-sealing compound if used, and other foreign material and shall be thoroughly moist before concrete is placed against them. Concrete shall be done only in thoroughly moist before concrete is placed against them. Concrete shall be done only in presence of purchaser or his duly authorised inspector if the purchaser so desires. The contractor ,therefore will intimate his program of cocreting in two days advavce so that, if required the purchaser may depute his representative The methods and equipments used for transporting concrete and time that elapses during transportation shall be such that it will not cause appreciable segregation of coarse aggregate or slum loss in excess of 304.8 mm in the concrete when delivered into the work. After the surface have been cleaned and dampened as specified. and immediately before angle shall not differ from the correct batter by more than 5mm per meter of exposed stub, The fitting for tower in tangent section of the line shall be placed so that the longitudinal axis of the tower will be in a place perpendicular to the transverse of the line. Unless otherwise direct by the engineer. the footing for such angle tower shall be placed so that the tower cross arms will be in a plane bisecting the interior angles so formed by the intersection of the transverse of adjacent of the line.

IX) REPAIR OF CONCRETE.

Any repair of concrete shall generally be avoided and. if at all, shall be performed by skilled workman and shall be repaired only in presence of departments authorized inspector. Repair of imperfections in formed concrete shall be completed within 240 hours after removal of fors. Concrete that is damaged, honeycombed, fractured or otherwise defective or having excessive surface depression shall be sound and free from shrinkage, cracks and dreaming area after the filling have been cured and have dried, the entire cost of repair of concrete shall be borne by the contractor.
Building of stone revetment might have to be done at selected location. Such work, if necessitated, will be done by contractor at the direction of department. Payment will be made at the unit rate indicated in the order and for the quality actually done.

X) FINISHING:
Normally if concrete is well placed it may have a finished surface but where finishing is required in the opinion of department, the same shall be done by the contractor in presence of departments authorized inspector. Exposed unformed surface and concrete shall be brought to uniform surface and marked with suitable tools to make it reasonably smooth, wood float finish. Concrete in the top of the formation shall be sloped to drainage from the steel stub angles. Excessive focting or toweling of surface while the concrete is placed will not be permitted. Joint and edge that will be exposed to view shall be chamfered.

a) Conductor shall not over tensioned.

b) Compression type repair sleeves shall be used to repair minor damage to conductor.

c) Ant vibration devices i.c. vibration dampers performed armor rods. shall be used

(XI) CURING

Curing will be done by concrete of water for a minimum period of fourteen days. Concrete shall be protected from direct sun for at least first three days of curing period.

(G) ERECTION OF TOWER

The tower shall be erected as per approved structure drawing and by standards methods/norms. If any shop error in the members are detected, the contractor shall inform the department who will decide whether the errors may be corrected in the field or the member returned to the manufacturer for rectification or replacement. when authorized engineer of department issues instructions to the correct mismatched holes, or other shop errors, final inspection of the tower will be made by the authorized engineer of department. Any identified error in erection of tower will be corrected by the contractor at no additional cost to the purchaser. All towers shall be truly vertical after erection and no straining will be permitted to bring them so maximum permissible tolerance will be 2.5 cm in 10 meter height of tower. The contractor will check the verticality of the tower in presence of purchaser's representatives. All nuts and bolts shall be drawn up tight but not to such a degree as to endanger the strength of bolts & nuts. After final tightening under temperature of bolts, threads shall be center punched so as to prevent loosening under temperature changes or vibrations. All bolts and nuts upto the bottom cross arms shall be tack welded.

H) ERECTION OF TOWER ACCESSORIES:

Each tower shall be provided with a number plate, phase plate, danger plate and anti climbing devices shall be provided in tower as approved by purchaser.

(I) STRINGING OF CONDUCTOR AND ACCESSORIES.

Scope of work under this item will comprise of assembly, hoisting of insulator strings, stringing of power conductors and installation of all conductor accessories as per details given below.

Concrete is placed, construction joints shall be covered, wherever practicable with a layer of mortar approximately 9.535 mm thick. Repapering of concrete will not be permitted. Any concrete which has become so stiff, that proper blacking cannot be assured shall be wasted. The concrete shall be lowered into the work by means of suitable drop shutters other than the methods that will prevent of concrete. Where the use of form is not required and the concrete is placed directly in excavation it shall be lowered in such a manner as to prevent it form dropping or flowing on the sides of the excavation. The concrete shall be placed in horizontal layer and the depth of which generally shall not exceed 500 mm. If considered by the department, concreting may have to be done in lesser depth where concrete in 500mm layer cannot be placed in accordance with the requirements of the specification. Concrete shall be consolidated to maximum practicable density, so that it shall be free from pockets of coarse methods or by electric or by electric or pneumatic driven immersion type vibrators opening speed not less than 7000 r.p.m. when immersed in concreted layers of concreted shall be placed until the layers previously placed have been worked thoroughly as specified. Care shall be taken to avoid contact of the vibrating head with surface of the form.

J) STRINGING OF EARTHWIRE:

Over head earth wire shall be strung for the entire length of the transmission line and shall be attached to the tower in accordance with details approved by the purchase.The equipment, method to be adopted for stringing of earth wire shall be similar as that stipulated for stringing of power conductor.

Joints/splice in the earth wire shall be provided at least 15 meters away from the structure and there shall be no joint in the crossing spans.

K) FITTING OF TOWER ACCESSORIES:

Towers will be fitted with following accessories

i) Danger plate, Phase plate, Number plate on earth tower.

ii) Ant climbing Devices on selected locations decided by department.

L) REVETMENT.

Building if stone revetment might have to be done at selected location. Such work, if necessitated, will be done by Contractor at the direction of department.

3.0 METHOD OF WORK:

The method of work to be adopted for erection of the line has not dealt with in detail but are left to the contractor who will exercise his own judgment and experience with regard to the best practice to be adopted for completion of the work subject to approval by purchaser. However, the contractor will have to take full responsibility for correctness of work and any defect/deficiency will be rectified/ redone by the contractor without any extra cost to department.

Insulator string comprising of insulator disc and all hard wares will be assembled at site, hoisted and attached to the tower cross arms.

Equipment and method needed for stringing the conductors shall be such that the conductor will not be damaged. Care shall be taken to ensure that conductor does not kink/get twisted or abraded. Power conductor while stringing shall be laid along the ground from reels and then raised or pulled into position through stringing blocks by means of running lines. The running lines shall be connected to the conductor with swivel connectors and stocking type grips. The end of grips shall be tapped to the conductor so that grips run freely in the shackle. Conductor splices shall not be allowed to hang in stringing blocks for more than 18 hours before being pulled to the specified sags. After sagging conductor shall be allowed to hang in stringing block for not less than 2 hours before being clipped into permit conductor tension to equalize. The total time, however to which the conductor will not be more than 48 hours. The conductor shall not be priestesses and shall be sagged in accordance with the stringing chars duly approved by department. The length of the conductor sagged in one operation shall be limited to the length that can be satisfactorily sagged. In sagging one reel length, the sag of two spans will be checked. In sagging more than one reel the sag of three of more span. one near each end and one near the middle of the length dragged, shall be checked. The length of the span used for checking shall be approximately equal to the ruling span. The sag of the all spans more then 450 M. and sharp vertical angles shall be checked on both sides of the angle. The sag of spans on both sides of all horizontal angles of more than 10^{o} shall be checked. After the conductors have been pulled to required sag. in mediate operation shall not be carried out in adverse weather conditions. During stringing. following care shall be taken in particular.

a) Conductor will not be dragged over ground and rough surfaces that might damage conductor. Suitable guards or sheaves shall be used. if required to protect conductor in place where it would be otherwise impossible to keep conductor coming in contact from objects, which might injure the conductor.
b) All conductor joints will be made as per recommendations of conductor manufacturers and shall not be less than 15 meters from tower structure not more than one conductor will have a joint in one span. There shall be no joint in crossing span for road/rail/canal/power line etc.
c) Adequate ground clearance and clearance between conductor to grounded tower parts shall be maintained.
d) Sag tension charts as approved by purchasert shall be needed.
e) Dynamo meter shall be used for conductor tensioning.
f) An extra sag of 6" to 12" than the minimum required shall be provided at important road/ rail crossings.

4.0 STANDARD/ACTS/RULES:

Except where otherwise specified, the erection testing and commissioning of the transmission line shall conform to the provision of IS:5613,1976 (Part-II, Section-I and II) Indian Electricity Act,1910 and Indian Standard specification listed below (latest revision) shall be applicable to the materials and process used in execution of work.

IS:4091-Code of practice for design and construction of foundation for trans. Lines.
IS:456-Code of practice for plain reinforced concrete.
IS:3043-Code of practice for ear thing.
IS:3764-Safely code for excavation work.
IS:4081- Safely code for blasting and related drilling operations.

5.0 RIGHT OF WAY.

The contractor will arrange the right of way/necessary working clearance of trees and other instruction on either side of the alignment of the line. During the construction works, there would be unavoidable damage to crops, trees etc. both in erection of the line and making temporary approach roads to the line. Compensation of this account, if any will be paid directly by the contractor. Any avoidable or deliberate damage done to standing crops or private property by the contractor's laborers shall be contractor's responsibility.

Any extra land required by the contractor temporarily for dumping of construction materials and consequent damage of crop etc. shall be the responsibility of the contractor. If any permission, permits are required to be arranged from any govt. or local authorities for smooth execution of the work. This will be arranged by the contractor as and when required jungle clearance/tree cutting, if any along the line shall be arranged by the contractor.

6.0 PERMISSION AND PRIORITIES.

If any permission/permits are required from any govt. or local authority for smooth erection of work the same shall be arranged by the contractor as and when required.

7.0 ACCESS ROADS:

Access roads for transport of material for construction of line will be made and maintained by the contractor as and when required.

8.0 TESTING & COMMISSIONING.

All pre-commissioning tests will be conducted within a month from the receipt of completion report by the contractor. Any defect found as a result of test shall be rectified by the contractor without any extra cost to the department. The rates are inclusive of all statutory inspections testing and commissioning charges and no extra payment will be payable on this **account.**

9.0 DRAWINGS.

The contractor will furnish ail relevant drawing/design required for carrying out works. The contractor shall however prepare detail drawings and get approved by the purchaser before commencing the work. Such approval however, will not absolve the contractor of their responsibility for correctness of drawings furnished and the work executed by them. The contractor shall be responsible for any alternations/modifications necessitated due to discrepancies/errors or omission in their drawings or other details furnished by them even if these have been approved by the engineer.

10.0 TAKING OVER OF THE LINE.

The lines when erected and completed shall be handed over to BSEB for maintenance purpose and it will be the contractor’s responsibility to get the line inspected by BSEB engineers and rectify the defects, if any pointed out by them and produce a certificate to this effect issued by BSEB.. Issue of such certificate. however, will not relieve the contractor of his liabilities and responsibilities in respect of work executed by them.

11.0 CLEAN UP OF WORK SITE

During erection, the contractor shall without any additional payment, keep at all times the working site and storage area used by them free form accumulation of waste, materials or rubbish. Before completion of erection. they shall remove or dispose off all temporary structures, waste and debris in satisfactory manner and leave the premises in a condition satisfactory to the purchaser.

12.0 CLEARANCE FROM GROUND/BULDING /TREES.

Clearance from ground building, trees will be provided in conformity with the Indian Electricity Rules,1956 as amended up to date.